UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

Title: MEETING WITH ADVISORY COMMITTEE ON NUCLEAR WASTE (ACNW) -- PUBLIC MEETING

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UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

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MEETING WITH ADVISORY COMMITTEE

ON NUCLEAR WASTE (ACNW)

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PUBLIC MEETING

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Nuclear Regulatory Commission

Commission Hearing Room

11555 Rockville Pike

Rockville, Maryland

Thursday, December 18, 1997

The Commission met in open session, pursuant to notice, at 10:07 a.m., the Honorable SHIRLEY A. JACKSON, Chairman of the Commission, presiding.

COMMISSIONERS PRESENT:

SHIRLEY A. JACKSON, Chairman of the Commission

GRETA J. DICUS, Member of the Commission

NILS J. DIAZ, Member of the Commission

EDWARD McGAFFIGAN, JR., Member of the Commission

STAFF AND PRESENTERS SEATED AT THE COMMISSION TABLE:

JOHN C. HOYLE, Secretary

KAREN D. CYR, General Counsel

DR. B. JOHN GARRICK, Chairman, ACNW

DR. CHARLES HORNBERGER, Vice Chairman, ACNW

DR. CHARLES FAIRHURST, Member, ACNW

DR. RAYMOND WYMER, Member, ACNW

DR. JOHN T. LARKINS, Executive Director, ACNW

P R O C E E D I N G S

[10:07 a.m.]

CHAIRMAN JACKSON: Good morning, ladies and gentlemen. Today the Commission will be briefed by the Advisory Committee on Nuclear Waste on several technical issues related to the management and disposal of radioactive waste.

The Commission always looks forward to the ACNW to provide it with its technical advice to assure the safe management and disposal of this country's radioactive waste.

Today's briefing by the ACNW will include discussions on three technical issues that are of great interest to the Commission. These topics include the application of probabilistic risk assessment or PRA to performance assessment in the NRC High Level Waste Program, performance assessment capability in the NRC itself in the NRC High Level Waste Program, and the implementation of a defense-in-depth concept in High Level Waste.

In addition to these technical discussions, the Commission will also discuss its priorities for the next year. The Commission looks forward to your presentation and unless any of my fellow Commissioners have opening comments, Dr. Garrick, Please proceed.

DR. GARRICK: Thank you. Perhaps before we start, Chairman Jackson, I would like to recognize two new members

of the Committee -- Dr. Raymond Wymer and Dr. Charles Fairhurst, and we're delighted to have them and put them to work as quickly as possible.

We have taken the liberty to restructure the agenda a little bit from what you described, and in particular, in order to establish a framework within which we can identify the relevance of the issues we are going to talk to you about, we are planning to talk a little bit about the priorities first.

CHAIRMAN JACKSON: Sounds good.

DR. GARRICK: And I think that one of the things that we have attempted to do with the presentation is to create somewhat of a theme, starting with the priorities or starting with the Strategic Plan as a proposed structure within which we operate, and getting into the performance assessment issue as a discipline and our comments regarding that, and then moving from there to, well, what capabilities exist within the NRC to deal with this subject, and then somewhat in the context of an example address the issue of defense-in-depth.

We hope that that theme is logical and appeals to you, so with that I will lead off the discussion, talking about the Strategic Plan.

What we have done here is pick up on your leadership for developing a Strategic Plan for the Agency

and root our plan in that plan and ask ourselves along the way about its relevancy to the overall plan of the Nuclear Regulatory Commission -- so we hope that that occurs. We hope also that this can become a benchmark, if you wish, with which we can measure our performance, and of course we expect to do this each year.

So if I could, I would like to proceed to the Plan. We have chosen to take a top-down approach just as the NRC Plan did, and to get into the whole arena of mission, vision, goals, objectives, and then finally the product that we want out of the Plan was priorities.

Our first exhibit here is what is the mission of the ACNW. Our characterization of that mission is that we are to provide independent and timely technical advice on waste management issues to support the NRC in conducting an efficient regulatory program that enables the nation to safely use nuclear materials.

Now with respect to our vision, the Advisory Committee on Nuclear Waste strives to provide advice and recommend solutions that are forward-looking, that are based upon the best available science and technology, and that can be implemented and reflect the needs and balance risk, benefit and cost to society to enable the safe use of nuclear materials.

As far as goals are concerned, we have identified

several goals. One of the goals of course is to position ourselves to be effective in our response to change and the attendant uncertainty that surrounds us in the management of nuclear waste, to provide assurance to the Commission that the best science is being employed in resolving key safety issues, and of course when we talk about that science we are talking about consistent with the constraints that we all have to work under; to provide advice to the NRC on how to increase its reliance on risk as a basis for decision-making, including risk assessment methods for waste, radioactive waste management; to support and assist the NRC in improving public involvement; and to optimize the effectiveness and efficiency of the ACNW operations.

CHAIRMAN JACKSON: Yes, please.

COMMISSIONER DICUS: On the fourth bullet, in assisting and improving public involvement, what are some of your ideas that you would be doing to help us improve public involvement that we are not already doing?

DR. GARRICK: All right. Well, I am not suggesting that we aren't doing some of these things, but a couple of things that come to our mind and that we have talked about a little bit is that we could probably be a little more deliberate in our outreaching for public involvement, in giving ourselves confidence that the public is well-represented on key issues.

We are in a position of anticipating these issues much further in advance than the announcement accommodates, and so I think that one aspect of this that we have been thinking about is perhaps there are some things we can do in the sense, in the context of an outreach program.

The other thing that I think is very fundamental to the whole notion of a transition towards a risk-informed regulation is that many of us believe very strongly that one of the most important mechanisms, one of the most important tools for reaching to the public is to have a framework within which issues are consistently and systematically addressed, including issues, comments, or input that might come from the public -- so those are a couple of thoughts.

COMMISSIONER DICUS: That's good. Thank you.

DR. GARRICK: Criteria -- obviously if you are going to have as an end goal of a strategic plan and development of priorities you need some sort of process that gives you some confidence that these priorities are properly connected to our vision and our mission.

The priorities that we have listed here are very consistent with the priorities that we have seen in the Plan for the Agency.

It's clearly protection of public health, workers, and the environment. We want certainly to be responsive to issues that the Commission is most interested in.

Timeliness is always a matter that is important in the effectiveness of any advisory effort.

We have also tried to measure the relationship of the issues to the Strategic Plan of the Agency, the potential for an issue to pose undue risk or surprises or things that would affect the reasonableness of the solution to that issue -- such as cost; issues arising from strategies and activities of licensees -- it seems that if you are going to be an effective advisor you need to understand the depth and breadth of the issues as viewed by the people that you are trying to regulate; and finally issues arising from technical basis for safety assessments.

So what this all led to was a set of priorities. We chose to divide these priorities into two categories, one that we chose to call the First Tier priorities, and of course a major consideration in something being First Tier is that it is something that needs to be addressed now, 1998.

We have also tried to cut these at a level where they convey some sort of an image that is less than generic that people in our business in the Agency identify something with, and so we have been rather sensitive to the labels here.

So the priorities, not necessarily in order of priority, that we have listed under the First Tier are the

viability assessment. We realize that this is not an official Nuclear Regulatory Commission requirement, but we also realize that as the Agency moves and positions itself to be increasingly effective in the licensing of repository for high level waste that this is an important opportunity for us to get involved, to see issues, to get a sense of what the licensee or the applicant is doing, and so we view this as a very important activity.

Risk-informed performance-based regulation -- I don't think we need to elaborate much on that. It's becoming an across-the-board issue of considerable importance to the Agency. We will be addressing it some more in our subsequent presentations.

We all know also that as the Site Characterization Program proceeds with respect to Yucca Mountain and as we learn more about the characteristics and the properties of that site, we learn a great deal more about what we are going to have to do in the way of modifying that site to give us confidence that it can comply with the standards and the regulations that are to follow.

One of those issues that has surfaced that is becoming increasingly important is that there is considerable evidence that perhaps there is going to have to be a greater dependence on engineered systems than maybe the way we were thinking a few years ago, and so we have moved

that up as a high priority.

Decommissioning is judged to be also a First Tier priority and it crosses a lot of activities and disciplines in the whole arena of waste management.

Then, of course, research -- this is an issue that has increased in importance for a few reasons. One is that this is a function that was handled to some extent by the previous Nuclear Safety Research Review Committee and the activities of that committee are having to be spared by the Advisory Committee on Reactor Safeguards and the Advisory Committee on Nuclear Waste and we want to be darn sure that we are forward-looking with respect to this research.

CHAIRMAN JACKSON: I think Commissioner McGaffigan has a question for you.

COMMISSIONER McGAFFIGAN: This may be more a statement than a question.

I just want you to be aware on the risk-informed, performance-based regulation, we had a meeting yesterday where we talked in reactor space about how far we can push, how rapidly we can push towards risk-informed regulation in that context and I believe the Strategic Plan says that risk-informed and as appropriate performance-based. We are still trying to define when it is appropriate and I think in the waste area I think we believe it is appropriate but we don't have a lot of guidance at the moment as to when it is

appropriate to use a performance-based rule as opposed to a more prescriptive rule, and I think we are still struggling to come up with the criteria for when one does that, so it is an ongoing -- we have made a commitment to try to make a transition to more risk-informed and to more performance-based or less prescriptive, but the words in the Strategic Plan were struggled over, and so I just point out the nuances to you.

DR. GARRICK: Yes.

CHAIRMAN JACKSON: I actually believe that that is in fact an opportunity.

DR. GARRICK: Yes.

CHAIRMAN JACKSON: For our advisory committees.

DR. GARRICK: Yes -- and we agree with that.

As far as the Second Tier --

CHAIRMAN JACKSON: Excuse me --

DR. GARRICK: Oh, excuse me.

CHAIRMAN JACKSON: Commissioner?

COMMISSIONER DICUS: Well, this could be for First Tier or Second Tier questions or slides rather. Have you within your First Tier -- did I hear you say you haven't really prioritized within the First Tier priorities. Is it as the issue comes up or as you may to discuss it?

DR. GARRICK: Well, we have not really fine-tuned it that much. I think each member of the committee has

their own preferences as to which is the top priority.

I suspect that the events will determine that as we proceed in 1998 and they take on a little different context because some of these issues will continue for sure way beyond 1998. Others are going to be much more short-lived.

COMMISSIONER DICUS: I don't know whether I should ask this question or not, but I guess I will. Even just looking at the First Tier priorities that you read, some of the items in the Second Tier priorities, it is a lot of work for a relatively small group.

That's more a statement than a question.

DR. GARRICK: You're absolutely correct, Commissioner Dicus --

CHAIRMAN JACKSON: Don't set him up to ask for more --

[Laughter.]

COMMISSIONER DICUS: When I asked the question, I thought I know I am going to get in trouble with this question.

CHAIRMAN JACKSON: You are.

[Laughter.]

DR. GARRICK: The only answer I can give is yes.

CHAIRMAN JACKSON: Thank you. Very good answer.

DR. HORNBERGER: I think in part, if I could just

interject, it's clear that we are not going to exhaustively approach all of these topics and the viability assessment we will do what we can when the products come through later in the year.

CHAIRMAN JACKSON: It's a triage, yes.

DR. GARRICK: Triage, yes. I think we are short of time and I don't think I want to dwell much on the Second Tier except to recognize them and to indicate that these not only reflect the application of our criteria but have involved a number of reviews of meetings we have had.

Commissioner Dicus made a major contribution to this when she attended part of our retreat.

We have received a lot of information from the NMSS as to what they believe are the priorities, so this is something that has come from a wide band of resource bases.

COMMISSIONER McGAFFIGAN: A question about just how the Advisory Committee with limits compared to ACRS operates.

We involved ACRS quite often in lots of Staff proposals, generic letters, whatever. We have in this long list of priorities items that come up.

One that comes to mind at the moment we and the State of Washington are struggling with is the Trojan reactor vessel with internals intact and whether it should be disposed of at Richland.

Do you see a role for yourself in advising the Staff and the Commission on these cases? I guess it's more casework. The ACRS I think does more casework.

You have thus far stayed at a higher policy level.

How do you see that in your committee's work?

DR. GARRICK: Well, I guess I would say first that we are here principally to respond to issues raised by the Commission, and if the Commission sees us as having an effective role in that arena we would, I think the committee would be delighted to do so.

I don't think that we see ourselves as fenced in on any particular way of operation. I would hope that we would have the flexibility to do that.

COMMISSIONER McGAFFIGAN: And this gets back to a fundamental question. I have noticed reading Nucleonics Week and other publications recently that there is a movement afoot or in France for example to question whether repositories are the appropriate role or if there may be a technology out there and some sort of interim approach, and then some technology comes along in 100 years, and that obviously -- my old Los Alamos sometimes -- cells accelerated transmutation of waste -- is that technology that may come along.

I know there is a big Academy report on that subject, but is there a role for you all in continuing to

inform us as to -- I know on the viability of the repository approach but on these alternatives that occasionally get talked about, whether they are indeed viable in your view?

DR. GARRICK: Well, Commissioner McGaffigan, I surely hope there is. Speaking for myself, this is what makes this job interesting is to be in a position to address broader issues than maybe we see in trying to set up our agendas and what have you.

I think that it is clear in our conversations among the committee that we have a very deep interest in alternatives, in interim solutions, in methods of timeliness with respect to when we get to a particular type of solution, and in the technologies that are involved, so I think that we would be very interested in that kind of involvement.

CHAIRMAN JACKSON: Actually, that leads to two comments.

One is that having recently been in France, I think the issue for the French is not rejecting the idea because I actually had a meeting with all of the nuclear players. It's not rejecting per se the idea of a repository but having a repository built in a way where it can either be permanently sealed or what is put into it being retrievable if a technology is developed that allows for disposition of the high level waste by some alternative

mechanism, and so we want to be careful in terms of how it is reported versus what the players are really saying.

DR. GARRICK: Yes. As a matter of fact, when we put the priority repository design on here, we were thinking of just those kinds of issues and the retrievability issue is a particularly important one that we sometimes think is not adequately addressed, and from a reality standpoint from an operational standpoint, and that is a very good example.

CHAIRMAN JACKSON: Go ahead, please.

COMMISSIONER DICUS: So it would cover, if I can change the terminology a little bit, the closed repository designs as well as maybe an open repository design?

DR. GARRICK: Yes. It's no question that our focus has been on a closed repository and post-closure but there is strong interest in alternatives and some of those alternatives involve modifications of -- interface that goes from open to closed.

CHAIRMAN JACKSON: Right. Exactly.

COMMISSIONER DICUS: How does your Strategic Plan track with the Agency's Strategic Plan?

DR. GARRICK: Well, I think -- and one of the things we are going to do is send you a copy of it -- and we have agreed on a letter to do that and you will be receiving that within the next few days. I think the attachment to our letter will be very apparent with respect to its

connection with the NRC Plan.

I would like to move on to the next topic, application of probabilistic risk assessment methods to performance assessment in the NRC High Level Waste Program, and

You have received a letter on this. As you observed from our letter, the primary issues that we identified had to do with the committee feeling very strongly that the true spirit and intent of the concept and the philosophy of risk assessment be sustained. Whenever we use it and apply it that it is a technology, a discipline that was sought out as an alternative to simplified calculations, to bounding calculations, to worst case analysis. It was intended to provide us more insight into the reality of what was going on with the system that we were interested in.

The issue here is that the committee wants to have a high degree of confidence that that quality is preserved in its application so this is more in the context of a caution and a consciousness, a concern than anything in particular.

The approach to performance assessment should clearly allow an exposure or a manifestation of those things that are driving the risk because that is what gives you the information you need to implement any kind of sensible risk

management program.

CHAIRMAN JACKSON: Yes, Commissioner.

COMMISSIONER McGAFFIGAN: On the first caution, you said there is nothing specific there, but is the fear that bounding calculations and worst case calculations have a way of creeping into so-called realistic --

DR. GARRICK: Yes.

COMMISSIONER McGAFFIGAN: -- models?

DR. GARRICK: Yes, that's true, and the fear that we are really doing a disservice to the public because in the way they are presented sometimes the public interprets them as being the real world and the real analysis and I think we need to be very cautious about that.

CHAIRMAN JACKSON: Yes?

COMMISSIONER DICUS: Maybe you are going to address this in the other slides, but given the fact that what we are doing is to review what DOE is doing, how would something like this track with what DOE is doing?

DR. GARRICK: Yes, I realize the roles are different.

I realize that the purpose of the Agency with respect to performance assessment is, first, to gain an understanding and increase knowledge about the facility or the site that they are trying to evaluate, and then second, to use it as a mechanism for giving them an independent

perspective, the independent ability to review what DOE does, so I think the point is well-taken and it is important to realize that our interest, the Nuclear Regulatory Commission's interest in the performance assessment is a different one than the licensee, and I think those are the two primary differences.

One of the things that we were briefed on last summer was the progress that the Commission has made with respect to performance assessment, the tools that have been developed, and we were very pleased to see that a great deal of progress has been made.

Revised NRC total performance assessment code Version 3.1 in our judgment represents a major step forward.

We are very aware that it has been a longstanding effort on the part of the Staff to collect the evidence to package the information that supports any analysis in an effective manner and that the Staff has continued to be interested in trying to gain this understanding that I spoke to of the processes that affect repository performance.

We think they have made a lot of progress in that regard.

CHAIRMAN JACKSON: I think Commissioner McGaffigan has a question.

COMMISSIONER McGAFFIGAN: Well, it really relates to -- you are praising on this page but on the page you are

going to suggest that --

DR. GARRICK: The good news and the bad news.

[Laughter.]

COMMISSIONER McGAFFIGAN: That there may be a need for TPA 3.2, which would get rid of what you call unrealistic results that arise from bounding calculations embedded in the code.

Is that in fact -- it's a pivotal effort but it isn't quite there yet, if I try to put these two thoughts together?

DR. GARRICK: Yes. I think that obviously we in our briefings and in the documentation we received don't always have a full view of everything that is going on, and we recognize that, and as a matter of fact, between the briefing in July and this meeting, we have had things brought to our attention that illuminate some of the issues that we were concerned about and in fact there is less concern, but one of the things that we were triggered on a little bit during our meeting and the basis for this letter was that it was the impression of some of the committee members that maybe not as much attention to detail was being given as could be with respect to some critical assumptions.

I think that we were especially focused in that meeting on the engineered barriers -- that was sort of a theme of that meeting -- and so we were looking very

strongly at a component of the repository design that perhaps the TPA 3.1 in its evolution had not quite caught up with in terms of its importance.

So, yes, we made some judgments that perhaps there were some assumptions having to do with the representation of the degradation of the waste package that were more conservative than we would have liked to have seen, but still in the context of my opening comment here, the approach we were taking was one of caution more than one of necessarily being unduly critical and reminding ourselves of what this discipline can do for us and what its underlying capability is.

DR. HORNBERGER: I would point out too that I don't think it is inconsistent with the Staff's position. That is, I don't believe that they see this as a fixed immutable instrument -- that they really do want to test things out and improve it in areas where they see improvement is needed, whether it is called 3.2 or just a revision of TPA 3.

CHAIRMAN JACKSON: Let me ask you this question.

In terms of trying to get at what you called some of the ultra-conservative model assumptions --

DR. GARRICK: That word --

[Laughter.]

CHAIRMAN JACKSON: How much is this related to a

conservatism that is cultural versus a conservatism that is based on lack of information?

DR. GARRICK: Yes. Well, I guess the way -- I know what you are saying. I guess a way that I would like to address that is that I think as technical people, and we certainly have to be sensitive to cultural conditions, but as technical people I think it is very important for us when we are talking about a parameter or a performance measure to do the best job we can of characterizing the full range of values of that measure.

Now by that we are not suggesting that we ought not to be conservative. On the contrary, the committee has been outspoken on that issue. We should be conservative, but if you do the former and you do it systematically and visibly, then the opportunity exists when you have decided to regulate on the basis of a value, the opportunity exists to see what the context is of that value based on reality, so that is the thought here.

CHAIRMAN JACKSON: But that is a key phrase you just used. You said based on reality, and that gets to my question about the informational base that is being drawn on.

DR. GARRICK: Yes.

CHAIRMAN JACKSON: And so if you could answer the question in that context, in terms of how can the Staff or

what needs to happen to have the models become more realistic?

DR. GARRICK: I think the one thing that is very important to do just what you are talking about is to make sure that when you present a calculation or a distribution that the evidence supporting that is very clear.

One of the things we also recommended strongly in that letter is that a lot of attention be given to packaging the supporting information such that one could make a connection between the values and the information base, and it reflects a philosophy I think that it's maybe not so important what the analyst does as it is what the analyst does on what basis -- what is the evidence, what is the information base that the analyst uses.

So what we have tried to do is put a little focus and emphasis on the source material, on the evidence base for the calculations.

CHAIRMAN JACKSON: Yes, Commissioner Diaz.

COMMISSIONER DIAZ: Just following up on the same issue, do you think it might be possible in some period of time to define what conservative means?

DR. GARRICK: Well, Commissioner Diaz. I am not sure, but I do -- this is one of the great attractions that the probabilistic thought process has to me is namely context, namely perspective, namely the full range of values

that you might associate with a particular analysis.

The key is whether or not you have sufficient supporting evidence to make that a reality.

There is always going to be uncertainty.

COMMISSIONER DIAZ: I understand, but in old-time engineering we used to take these safety factors and sometimes a safety factor of two was fine and sometimes a safety factor of four was fine.

DR. GARRICK: Right.

COMMISSIONER DIAZ: You know, at one point we have to maybe decide is it a factor of 10 what being conservative is.

DR. GARRICK: Yes.

CHAIRMAN JACKSON: Commissioner McGaffigan. You had a question?

[No response.]

DR. GARRICK: So I am going to move to the interpretation of results.

I think we have been talking about -- and I am not going to say much about that because key similarities of PRA and PA we did discuss at the last Commission meeting.

They have a great deal of similarity. They both can be scenario-based. If you talk about a scenario-based approach, you are talking about initial conditions and end conditions.

In the reactor game we talk about initiating events. In our game we talk about initial conditions, end-states.

We have an advantage in the waste field in that the end states that are the most likely going to be defined, and we are looking forward to EPA doing that, is a health standard of some sort, a dose standard, and so we don't have to have a surrogate for health effect, we can calculate it, so it lends itself very nicely to a risk-based approach.

There are some dissimilarities.

One of the things we talked about in this letter is the need for a mechanism, a tool for analyzing the results, for being able to take the results and take advantage of how those results were assembled and unravel them in such a way that one can see the effect of intermediate results on the bottom lines.

We know Staff is working on that. We are going to continue to push for that because we think that that is absolutely key to making this process an acceptable process.

We talked about specific methods that are employed to do this. We mentioned the event tree. We are not religious about that. There are other methods and we are open to those kinds of suggestions, so our conclusions relative to probabilistic performance assessment, we do believe that sustaining the properties of risk analysis, of

doing realistic analysis is important.

We want to make a contribution to having that be a conscious thing on the part of the people doing the work, and we are suggesting that, in conclusion, that the Staff look very hard at some sort of a post-processor that makes this whole issue of interpreting the results of the PA a more manageable one, and we are convinced, especially following our meeting, that they are working on this.

CHAIRMAN JACKSON: Thank you. Commissioner?

COMMISSIONER DICUS: A couple of questions.

One, on the use of the post-processor, you said the Staff is working on this, that they seem to be agreeable to do this, that this is the right direction to go?

DR. GARRICK: Yes, they are agreeable.

I think that as most of the problems in life are communication problems, everybody has their own language as to -- in this field when they practice this, and they become strongly identified with that language and the images that come out of that, and I am certainly no exception to that and the committee is no exception to that, so we have had a little bit of difficulty understanding each other on how we are doing this and I think we need a lot more briefings and interaction, especially with respect to developing a more in-depth understanding of TPA 3.1 before we can really say we are getting together on this.

So I think there is work to be done, but I suspect a lot of that work is understanding each other.

COMMISSIONER DICUS: What about, again thinking about DOE, is DOE doing anything like this, are you aware? I don't know if we know.

DR. GARRICK: DOE needs this. There is no question in our mind that they need it. We understand that they are doing some things. We don't know for sure what they are.

They attended the same meeting where this was discussed. They did comment at the end of that meeting they thought they were doing most of what we were talking about.

Based on what we have seen, what we have heard, we are not convinced of that, and also down the road in the licensing process it's going to take a lot more interaction.

CHAIRMAN JACKSON: Is this being done within a laboratory, DOE laboratory, or is it done by other DOE -- you know, staff?

DR. GARRICK: The team that is doing the TSPA, the Total Systems Performance Assessment, is made up of -- that is one of the things that concerns us.

There's a lot of laboratories, universities, M&O contractors, DOE staff that are involved. I think that one of the biggest challenges they have is the integration of the inputs that they are --

CHAIRMAN JACKSON: Well, you know, I told them that two years ago.

DR. GARRICK: Yes. Well, you were right on.

CHAIRMAN JACKSON: Yes, actually -- I mean it was clear then in terms of how the work was tracking and who was, you know, who was pulling it all together.

COMMISSIONER DICUS: And one more just quick question. Making these shifts a little bit with the staff and more realistic models and all, have you thought about resource implications for the Commission?

DR. GARRICK: Yes. Yes, and we know --

COMMISSIONER DICUS: Do you have them?

DR. GARRICK: There are resource problems. The NRC Staff clearly does not have the resources that DOE has to work on performance assessment and so they have to be much more selective in what they do, and it is a constraint. No question.

COMMISSIONER DICUS: Thank you.

CHAIRMAN JACKSON: Part of the reason I asked the question also had to do with -- about information bases -- is the input to this process from the Center, the Nuclear Waste Regulatory Analysis.

Do you have a sense of how the work that that center is doing is being integrated into --

DR. GARRICK: I am not sure we completely

understand that.

I know one thing that the committee is in agreement on is that the Center has a very important rule and that we feel that their involvement is extremely important and there's some integration problem there too. It's a little simpler.

CHAIRMAN JACKSON: Right.

DR. GARRICK: Than DOE's.

CHAIRMAN JACKSON: Commissioner?

COMMISSIONER DIAZ: Yes. Going back to something you said a while ago and to this you said that when you do your PA analysis it's different than reactor because your end point is better known.

What is the implication of the recent, you know, Chairman of ICRB suggesting that we go to a 30 millirem per year and back off collective dose if that -- what I am asking is would that knowledge make the process of analyzing these things, if you really know what dose you are going to, easier and less resource intensive?

DR. GARRICK: Commissioner, you have just touched on a subject that will take us 10 meetings.

[Laughter.]

DR. GARRICK: There is no questions that some decisions on collective dose and thresholds would have a major impact on end states and how we deal with them.

This is a very critical issue. If I had to guess an issue that might find itself on the top tier next year, it would be that one. It would be the whole issue of thresholds and --

COMMISSIONER DIAZ: And so would you recommend some time that the Commission makes this an issue that needs to be resolved with whatever means we have to address it?

DR. GARRICK: Yes, I would. Very much so.

All right. What I would like to do now is move into our third presentation actually -- Dr. Wymer.

DR. WYMER: Thank you. We have passed over into some of my areas in some of these questions and responses.

I would like to take just a minute to put this in context a little bit and to explain some of what I will say, which may differ somewhat from the viewgraphs in a few minor ways.

We have prepared three letters on this subject of performance assessments spaced roughly at three year intervals. I think the pace will quicken as we get closer and closer to the repository licensing action and I will add, too, what we are embarked on here in the performance assessment for the Yucca Mountain Repository is very large, very costly, and probably more importantly from the point of view of our considerations is in many ways unique with respect to the knowledge base required and with respect to

what the input to the performance assessment has to be.

That to a large extent has set the stage for much of what the NRC has had to do.

So with that little introduction, I would like to get into it. Now since we wrote the letter to the Commission on the eighth of October and subsequent to that, toward the latter end of November, we got a very detailed response from the Executive Director of Operations that dealt with a lot of our suggestions and in fact pointed out that not only had they been considering these suggestions that we made, we'd like to think it's based on our previous communications and discussions, but also largely to their own initiative, and had in fact planned to deal with many of these issues that we have raised, which is very gratifying, and in some cases had actually acted on them.

So with that little background, I'll move on to the first viewgraph.

We thought we would start off on a positive note and -- and it will stay pretty positive -- and point out the accomplishments that the NRC Staff with the support of the Center have achieved.

One of the things we were particularly concerned about was in light of budget cuts and reduction and the ability to carry out some of the support for the key technical issues, of which 10 have been identified, whether

or not the NRC would be able to go ahead and do what it needed to do in a timely enough way to meet the needs for the review of the total system performance assessment viability assessment and the license application and what we have learned is that in fact the Staff has been very clever and has managed to reassign some of the key parts of some of the key technical issues to other, better supported key technical issues in order to keep things alive and make sure that the essential things are moving, so that has happened.

Now as you know, the key technical issues and the Issue Resolution Status Reports are the mechanism by which this whole process is carried forward. As the key technical issues are addressed and the technical requirements are established, the input then is fed into the performance assessment people and there is a necessity for a close symbiosis there and that is well-integrated as far as we can see and takes place quite well.

I have the next list of accomplishments here.

With respect to the total system performance assessment viability assessments, there have been a number of communications between the NRC Staff and the Department of Energy staff on the code development and on the resolution of issues and on the convergence of what the key technical issues in fact are.

That has been very important in leading toward

preparing for this review. We don't expect, based on what we have heard, that the Department of Energy will receive any great surprises downstream, that in fact there will have been enough discourse that while there may be a disagreement, there may not be any surprises -- or certainly not many. I think that is a very positive thing the Staff has accomplished.

With respect to the code, which is in many senses the proof of the pudding, it is the tool that will be used in assessing DOE's license application and capabilities, one of the most important tools, we have been gratified to see, and this came up in the previous comments, that the code has been upgraded.

It's recognized as a living document, something that will be continually upgraded as sensitivity studies are made and shortcomings in it or deficiencies in it are unearthed.

It's my understanding that the code was completed in September and right now there have been some sensitivity tests performed on modules of this code and there will be a user's manual.

This gets to the point that was raised of what is the backup information, what is the documentation, how do you know really what the code has in it and what it will do, how well-based, how well-founded it is. There will be a

user's manual we understand, produced in early 1998, which will detail what the input is, what the assumptions are, what in fact the code consists of, and we are looking forward to seeing that just to see how well it does meet this advertised goal.

We'll move on to the next viewgraph then. One of the things that we have sort of honed in on is the issue of the engineered barriers. What we have observed is that as time goes on, DOE has more and more come to recognize that geology alone is not going to be the whole answer or not enough will be known for that to be the whole answer, and in complying with the response to the defense-in-depth concept which they are obliged to correspond to, that they are getting closer and closer to the waste package with respect to doing analyses of retention of radionuclides and what this means to the final dose.

So that gets into the issue, the whole question of engineered barriers as it relates to the defense-in-depth concept, which George Hornberger will address here next.

CHAIRMAN JACKSON: Let me ask you a question here.

You mentioned the reduction of the Center's efforts on the KTIs related to engineered barriers and radionuclide transport.

The question is, are you suggesting that the KTIs need to be reprioritized in some way?

DR. WYMER: No. What in fact has happened is since we wrote our letter we have learned that there has been a few additional people brought on to deal with these specific areas, in the areas that we have suggested, specifically, and there has been an increased level of funding associated with the KTI on radionuclide transport and particularly near-field.

CHAIRMAN JACKSON: And when you talk about the specific needs in engineering analysis, material science, and chemistry, are you saying that the staffing level in inadequate or that there is an absence of these disciplines?

DR. WYMER: It depends. I think more staffing could be used to advantage.

There is not a total absence in any of these areas, but because of the increased stress and emphasis on engineered barriers, enhancement would certainly be desirable.

CHAIRMAN JACKSON: I see.

DR. GARRICK: I think that when we heard the presentations in July, one of the senses of the committee was that if there was an area where we had not seen as much capability and expertise as perhaps we would like, it was the area of analyzing the containment capability integrity of the engineered systems, so I think that this was a particular point that we were focusing on in view of what

has happened at DOE in their TSPA over the last two years and the growing dependence on engineered systems to demonstrate the kind of performance they want to achieve.

So we were really suggesting that it is not to say the NRC doesn't have that kind of capability. It was only to say that we hadn't seen it.

It was not as visible in the presentation and in the documentation. As we learn more about TPA 3.1, we are seeing more and more.

CHAIRMAN JACKSON: I see. Commissioner McGaffigan, did you have a question?

COMMISSIONER McGAFFIGAN: No.

DR. WYMER: Okay. We have attached enough importance to this whole issue of engineered barriers that we are in fact going to convene a workshop on this subject we hope in March or no later than April of this coming year.

CHAIRMAN JACKSON: Will it be a workshop to which you will invite international participants?

DR. WYMER: We will do our best to invite the best people. There is a lot of work going on.

CHAIRMAN JACKSON: That's right.

DR. WYMER: That's right.

International -- there's a recent meeting that's directed in part toward this topic, and there are some very good people working in the field outside of this country,

and we hope that the outcome of the workshop will be a focusing of attention on this area and a highlighting of some of the needs which perhaps haven't really emerged as clearly as they should up to this point.

DR. GARRICK: Just a quick observation on that, because I think it's an important point, namely the international.

The committee is fortunate that Dr. Fairhurst is on the committee, because he has been extremely active in the international community and probably knows every rock-hound --

[Laughter.]

DR. GARRICK: -- in Europe and other places on this topic, so we take that question very seriously.

Can we go to the next viewgraph?

This is -- this is not meant to do any more than -- it is not meant to do any more than to give you an idea of what the near-field looks like in one of the -- or will look like in one of the drifts in the Yucca Mountain Repository.

And the point I wanted to make on this viewgraph is that it is an extraordinary complex system, starting in the middle with the fuel, which has its own barriers to release, and inside the canister there could be additional barriers provided if that were found to make a positive

benefit. And then's there the cask itself which provides not only containment, but a potentially chemically reducing environment, which further complicates the issue maybe with respect to transport of thing like technetium and neptunium, which move rapidly in their common valent states, but which, if reduced, might behave very differently.

And then that shows a drip shield which is another -- another engineered barrier feature. And then surrounding the entire thing, but within the concrete liner, wall liner, there can be another filler material which can either be chemically reactive or not, depending on the value of providing that kind of reactivity.

So the general point I wanted to make is that, just within that drift, we have an extraordinarily complicated system that requires analysis and it remains to be seen how important each one of the features, or changes in those features inside that drift can be to the ultimate retention of radionuclides and whether or not it is effective in the 10-year, 100-year, or 1,000-year time frame. These are things which need to be ferreted out, and that's all I wanted to do with that.

CHAIRMAN JACKSON: Yes.

COMMISSIONER McGAFFIGAN: Just on the picture, is the idea at DOE that they will add these barriers over time? The issue we talked about earlier, retrieveability for 100

years, or whatever.

DR. WYMER: Yes.

COMMISSIONER McGAFFIGAN: If you have backfilled with a lot of rock, that may or may not be chemically active, it looked like it would be pretty hard to take --

DR. WYMER: It's kind of hard, yeah. What we understand is that they plan to not backfill for about 50 years. In order to give time to see how things play out. And then if things look pretty good, and there is no real problems and no objections, then they would -- then they would go in and backfill, and then it does get difficult to do anything after that. But they -- they see it 50-year, give or take.

DR. HORNBERGER: Our understanding is that most of the things on that diagram are not part of DOE's reference design.

DR. WYMER: Well, the things that aren't -- if we could have it up there again. Are the things that are in yellow. Like ceramic coating is not. They are not taking credit for the cladding and the backfill is not in the reference design. But this is the design, I was told by Jack Bailey, the man in charge of this, that they are in fact working to, even though it is not their, quote, "reference design."

DR. GARRICK: Well, the reference design for the

viability assessment is this minus --

DR. WYMER: Minus what is in yellow.

DR. GARRICK: Minus the thing that is in yellow. Yes.

DR. WYMER: That's right. That's correct.

These other things in yellow are things that could conceivably add to the integrity of the system.

CHAIRMAN JACKSON: Well, this is a clear case where the technical decisions are policies.

DR. WYMER: Yes. That is absolutely right.

I wanted to, in the interest of time, to pass on the next viewgraph called Requirements of Realistic Performance because a lot of that has been covered one way or another already. And go on the conclusions. Our conclusions by and large are favorable. We think that there has been substantial and good work done on the EPA 3 Code.

We have a few concerns. We would like to see the code verified and benchmarked. So far what has been done is has been measured against DOE's corresponding code. DOE's is much more complex because they have the burden of providing a license application. The NRC has the burden only of checking them and making sure that we agree with what they say on whether it is right.

We do think that it would be good to get the code out for peer review as soon and as thoroughly as possible.

The unique aspects of the situation do mean that benchmarking is difficult because it can't -- there is nothing to benchmark it against in some cases, although certain modules can be benchmarked.

And, quite important, we think this whole thing of maintaining computer -- adequate computer capability is central, because the code is central, and the code is a computer code. Therefore, you must be able to have the resources at hand to run the thing, and to adequately carry out the calculations in a timely manner.

COMMISSIONER DICUS: Excuse me.

CHAIRMAN JACKSON: Yes, Commissioner. Go ahead.

COMMISSIONER DICUS: Yes. We may have the same question.

CHAIRMAN JACKSON: Well, go ahead, Commissioner Dicus.

COMMISSIONER DICUS: We are talking about the computer capability. I think I heard you say resources. So are you talking about expertise, or are you talking about software and hardware, and expertise?

DR. WYMER: To a large -- hardware is sort of central. I think that the -- there could be more manpower put on it for analyzing the code and doing the sensitivity analyses, those are very important. And, as a matter of fact, I could mention, I guess, to a certain extent, the

information is not available, and in other ways, it is not sought for doing the actual probabilistic risk assessment, or the code, but rather their sensitivity analyses are done on individual modules, which in fact cover a range and allow you to establish what the -- what the swings are in performance under various parameters, and so.

COMMISSIONER McGAFFIGAN: To follow up, what is the hardware capability at the moment that you are finding locking or potentially locking? Do we not have powerful enough hardware either here or at the Center to run the codes as they develop?

DR. WYMER: Well, I am little bit like Roy Rogers, all I know is what I read in the newspapers. All we know is what the -- what the staff tell us. I, personally, do not have the capability, the background to evaluate it. But we are -- we are told that they would like to somewhat increase their capability and it might be that some sort of a separate presentation on that specific point might be desirable.

DR. HORNBERGER: There was a concern they would be unable to maintain the current capability in terms of hardware. And so the first worry is not take a step backward.

COMMISSIONER McGAFFIGAN: The other question that really follows -- you have talked about most of the other

suggestions previously. The thrust of these is to add, although the staff has clearly responded on the KTIs with regard to engineered barriers and radionuclide transport, but are there any areas that the staff is working on at the moment that perhaps we could scale back the effort in order to make room for some of these things that you are suggesting we work more on?

DR. WYMER: That is hooked directly to the KTIs, and in some of those, like the vulcanism and tectonic areas, they are farther along than they are in others. And so there probably is some grounds for discussion of how near complete they are and what the relative importance of these are, but we have been told and there are pieces of paper that support the feeling that some of these areas are nearing completion.

CHAIRMAN JACKSON: Do you have a sense that the staff has a plan, a migratory plan to go from a focus in some of these areas to the areas that need more focus?

DR. WYMER: She's looking at you.

DR. GARRICK: Well, --

CHAIRMAN JACKSON: When I, this is only way I know to communicate.

DR. GARRICK: We are assured that they do. But at the risk of getting in a little trouble, to answer Mr. McGaffigan's question, I think that some of us would

certainly want the Commission to look at, if they are resource-constrained, the tradeoff of some of the earth science capability for more engineering capability. Because the whole industry has -- is transitioned from an earth science dominated issue to more and more engineering involvement. So, as a general statement, I think -- and if I were -- had an organization such as they have, that is probably where I would begin to look. And I had no more FTEs that I could add -- that is a term I have learned about since coming here. So --

CHAIRMAN JACKSON: Okay. Earth sciences versus engineering.

DR. GARRICK: Yes.

CHAIRMAN JACKSON: One E for another. All right.

DR. WYMER: One final point I wanted to make is that we would like to see an enlargement of the -- of the scientific basis for treatment of the near-field radionuclide mobilization. And there's a lot of information available. It has not been developed in the context of this problem, but it certainly is directly relevant to this problem. An enormous information base can be tapped. It probably should be done more systematically and in more detail than it has been, and I think to this point it hasn't been just because there hasn't been a recognition of the importance of the near-field like there is now, and the

resources are -- are bounded.

CHAIRMAN JACKSON: Right. Okay. Yes?

COMMISSIONER McGAFFIGAN: Is that an additional KTI or is that something that would need to be done within the context of the existing KTIs?

DR. WYMER: That is a subissue under the KTIs, yes.

COMMISSIONER McGAFFIGAN: Okay.

CHAIRMAN JACKSON: I think we had better on.

COMMISSIONER McGAFFIGAN: Yes.

CHAIRMAN JACKSON: Because we are running out of time here.

DR. GARRICK: Dr. Hornberger will talk about defense-in-depth and the letter you have received on that subject.

DR. HORNBERGER: Yes. I see we are running out of time. They tried to kid me that I was batting clean-up. But we all knew.

I have some comments that I would like to make on the letter than we sent you on October 31st, 1997. And, clearly, the whole issue is the revision of 10 CFR 60, the site-specific revision that is to follow on the heels of the EPA site-specific regulation for or standard for Yucca Mountain.

Just a bit of history. I guess it was last spring

Janet Kotra gave us a wonderful presentation sort of illuminating for us the thought process that went -- that people went through to come to the current 10 CFR 60. And Jack Sorenson, this summer, wrote a nice paper for us in which he did a lot of research on where defense-in-depth crops up in the regulations in NRC. And it is quite interesting that defense-in-depth is something that we all adhere to but --

CHAIRMAN JACKSON: Don't know what it is.

DR. HORNBERGER: Right.

[Laughter.]

DR. HORNBERGER: It is a nice picture, but it is a little fuzzy.

CHAIRMAN JACKSON: We are comfortable with that that we have used for 30 years.

DR. HORNBERGER: That's right.

CHAIRMAN JACKSON: We don't know anything more about it than the concepts, which we may not know about either.

DR. HORNBERGER: And it is good. And then Charles Fairhurst yesterday showed me the French, the "Defense en Profoundeux" -- I apologize to anyone who actually speaks French. But the French concept is also quite different from ours.

So, at any rate, the first thing that we did is

we, for ourselves, we said that defense-in-depth, when we talk about it, was going to refer to methods of design, construction and operation of a geological repository in ways that ensure safety in the face of considerable uncertainty. And given that still kind of soft definition of defense-in-depth, we came to the conclusions that this was an opportunity for us to look at our risk-informed approach to -- to the regulation. And, in fact, we concluded that the specific re- -- subsystem requirements, prescriptive requirements in terms of the rule, really were unnecessary. There's more -- this is sort of the bottom line of the whole letter.

We think that an overall performance-based standard is a superior tool.

The next slide, in terms of background, I think, again, perhaps a more logical way, I would go to the second bullet for -- first. We certainly endorse -- I think everybody in the whole business, worldwide, endorses the concept of defense-in-depth, and we recognize this need for the dependence on diverse barriers. We certainly support the concept in 10 CFR 60 that both the engineered system and the geological system should make contributions to safety.

What we -- the conclusion we came to, what we do not support at this time is the furthering of rule-based prescriptive subsystem requirements in the Yucca Mountain

site-specific standard.

I threw in --

CHAIRMAN JACKSON: Let me make sure I understand what you said.

DR. HORNBERGER: Sure.

CHAIRMAN JACKSON: So you are rationalizing defense-in-depth with the risk-informed in the following way. If you want to look at some net system performance that involves both the engineered piece and the natural piece, and that you recognize that each one makes a contribution, as you have said, and you can optimize that, but you don't to separately, and within each one, propose specific requirements, because you are saying in the end you may not have optimized. Is that your point?

DR. HORNBERGER: That is correct. Maybe we should write that down.

[Laughter.]

CHAIRMAN JACKSON: The transcript will show it.

DR. HORNBERGER: I put in the next slide of the Matruschka because this is -- it is an image that is used quite a bit in radioactive waste.

CHAIRMAN JACKSON: That's cute.

DR. GARRICK: We were going to bring you each one. We decided that was pushing it a little.

CHAIRMAN JACKSON: I think that's --

DR. HORNBERGER: Charles McCombie sent me a nice video that the Europeans did. Perhaps you have all sent it. Which is a public information video in which extensive use is made of this metaphor of the Russian doll. And I think for public education, it serves a very useful purpose. It has some limitations carried to the technical extreme, however, and the next slide also comes from -- from Neil Chapman's book. And we begin to see that -- how we can somehow use this metaphor to say, yes, we have these diverse barriers, each playing a role.

The problem is that we shouldn't get too caught up in the notion that while if one of the -- one component breaks, then we are going to be saved by the next shell in this Russian doll. And so I just wanted to point out that we went through this and had long discussions and -- I shouldn't say that. We didn't discuss -- we discuss the Russian doll.

COMMISSIONER DICUS: How do you address, and without getting, carrying on too long, an event that would challenge several systems? I mean how do you -- you have to take that into account.

DR. HORNBERGER: Yes.

COMMISSIONER DICUS: A paving machine can run over this doll and it is gone.

DR. HORNBERGER: And then -- and then it is gone.

Right.

COMMISSIONER McGAFFIGAN: This doll.

[Laughter.]

COMMISSIONER DICUS: And with -- dealing with the public, that's, I mean --

DR. HORNBERGER: Yes.

COMMISSIONER DICUS: -- that's, as a member, if I were a member of the public and this was brought as a way to, you know, these protective barriers, I would say, well, I can run over that with a steamroller and I don't have any protective orders. So you just have to be careful.

DR. HORNBERGER: Yeah. No, that is correct. And I mean even in the repository context, obviously, if one has a volcano --

CHAIRMAN JACKSON: A cataclysmic event.

COMMISSIONER DICUS: Right. Exactly.

DR. FAIRHURST: It is perhaps a little more appropriate to react to context where there is an external environment that is immediately accessible, where there is an underground geological environment that has got its limitations.

DR. HORNBERGER: Okay. Let me go to the recommendations that were part of our letter, because, again, the whole letter has been summarized very nicely for us. Our recommendation is to use performance assessment to

quantify the effectiveness of individual barriers. Again, as John said, our whole approach, the way we think about risk-informed decisions is that if we can get in front of us what are our expectation is for the behavior of the system, we can then make informed decisions.

DR. GARRICK: I think an important point on this is that we are -- because it can be misinterpreted, is we are saying put more emphasis on the individual barriers. Put enough emphasis on the individual barriers that you do a better job of quantifying their role in various scenarios, including cataclysmic events or volcanic events, as long as you carry with that the likelihood of the event.

DR. HORNBERGER: Right. In fact, the second recommendation is that we really think that DOE should, or any license application in the future should be required to demonstrate the contributions, quantitative, including the uncertainties that come out of a PA. And we also think that the -- that guidance can be given implementing the DID concept in a revised 10 CFR 60. In our mind, that feeds back really to the first recommendation, that this guidance would probably take the form of how one would expose the contributions in a rigorous way using a PA effectively.

CHAIRMAN JACKSON: Go ahead.

COMMISSIONER DICUS: Just, I had this note on his questions. I almost hate to ask, but this last bullet, "NRC

should set forth sound principles." Give us an example of a sound principle. I mean -- what you mean or define the term a little bit.

CHAIRMAN JACKSON: We are back to these adjectives.

DR. HORNBERGER: Yeah, the adjectives. Yeah. I wish we had taken that out, right.

[Laughter.]

DR. HORNBERGER: No. The -- it is very difficult for me, of course, to -- to give very precise -- a very precise answer. And perhaps the wording is a little awkward. But we think that guidance in terms of the performance to be expected can be given, and should be given. We don't think that subsystem requirements are appropriate in a rule. But certainly through guidance, one can set forth ideas on how one would actually go forward in a performance assessment to do what we say in the first bullet there, to expose the contributions.

DR. GARRICK: I think this is clearly an issue we expect to deal with a lot more.

DR. HORNBERGER: Yeah.

DR. GARRICK: We expect to interact with the staff, but you have just received a letter, for example, from the ACRS on the characterization of parameters, point values versus uncertainty, where that is a specific example

of the kind of guidance you might want to give in how you characterize the performance of an individual barrier.

CHAIRMAN JACKSON: I understand.

DR. HORNBERGER: Let's see, I put in the next slide. This is a draft from the staff as to how they envision the -- well, the structure framework for a total system performance, and I think that it just illustrates that there are points at which you could interrogate the analysis to actually get at the contribution of these various processes or the -- and the importance of key technical issues in the staff's framework for how they are going to deal with that.

So the conclusion, we think that the approach that we recommend allows to take advantage -- one to take advantage of site- and design-specific properties and features, that it clarifies the degree of dependence of the overall performance of individual barriers, and exemplifies risk-informed performance-based regulation.

CHAIRMAN JACKSON: Thank you.

Any further questions?

I had one question for you, Dr Larkins. You know, as I look back at the Committee's outline on its strategic plan, and it laid out its goals and its criteria, for instance, to select the priorities, leaving aside the specific priorities, how much concurrence is there between

the ACRS -- does it have a plan and --

DR. LARKINS: Yes.

CHAIRMAN JACKSON: -- do its goals and criteria track with those of the ACNW?

DR. LARKINS: Fairly closely. Both Committees are revising their operating plans right now to reflect the new priorities that are being developed. They track pretty closely with the Agency's operating plans and I think they are -- there is consistency between the two.

CHAIRMAN JACKSON: Okay. Thank you.

DR. LARKINS: I can't quantify it. I mean there's differences, obviously.

CHAIRMAN JACKSON: The Commission would like to thank of all you for a very informative briefly. Obviously, you know, even though we are being very careful, we have a keen interest in the use of PRA in the regulation of nuclear facilities and activities, including waste disposal. In fact, as part of the PRA implementation plan, as you know, Margaret Federline has a piece of that relates to looking at the use of PRA and those kinds of approaches in the context of waste management.

It, you know, it does seem that it can provide useful insights into the performance of a repository, and we encourage you, as well as the staff, to continue your explorations along these lines. Your views are very

important to the Commission on these matters because you have the broad-based expertise and the opportunity to stand back and look at these things from a more reasoned point of view.

I am intrigued about the idea of the International Conference. And so the Committees are to be commended for the high quality of today's briefing. And I really appreciate it and the Commission appreciates it a great deal.

So unless there are any further comments, we are adjourned.

[Whereupon, at 11:26 a.m., the meeting was concluded.]

CERTIFICATE

This is to certify that the attached description of a meeting of the U.S. Nuclear Regulatory Commission entitled:

TITLE OF MEETING: MEETING WITH ADVISORY COMMITTEE ON NUCLEAR WASTE (ACNW)

PLACE OF MEETING: Rockville, Maryland

DATE OF MEETING: Thursday, December 18, 1997

was held as herein appears, is a true and accurate record of the meeting, and that this is the original transcript thereof taken stenographically by me, thereafter reduced to typewriting by me or under the direction of the court reporting company

Transcriber: _____

Reporter: _____

Jon Hundley

UNITED STATES
NUCLEAR REGULATORY COMMISSION
ADVISORY COMMITTEE ON NUCLEAR WASTE
WASHINGTON, D.C. 20555

December 11, 1997

MEMO TO: John C. Hoyle
Secretary of the Commission

FROM: John T. Larkins, Executive Director
Advisory Committee on Nuclear Waste

SUBJECT: Advisory Committee on Nuclear Waste Meeting with the U.S. Nuclear Regulatory Commission, December, 18, 1997 -- Schedule and Background Information

The ACNW is scheduled to meet with the NRC Commissioners between 10:00 and 11:30 a.m. on Thursday, December 18, 1997 to discuss the items listed below. Background materials related to these items are attached.

- Introduction by NRC Chairman, Dr. Shirley Ann Jackson 10:00-10:05 a.m.

- Presentations by Advisory Committee on Nuclear Waste

1. Priority Issues for the Advisory Committee on Nuclear Waste
   - Dr. B. John Garrick, Chairman ACNW 10:05-10:20 a.m.

2. The Application of Probabilistic Risk Assessment Methods to Performance Assessment in the NRC High-level Waste Program (10/31/97)
   - Dr. B. John Garrick, Chairman ACNW 10:20-10:40 a.m.

3. Comments on Performance Assessment Capability in the NRC High-Level Radioactive Waste Program (10/08/97)
   - Dr. Raymond G. Wymer, ACNW 10:40-11:00 a.m.

4. Recommendations Regarding the Implementation of the Defense-in-Depth Concept in the Revised 10 CFR Part 60 (10/31/97)
   - Dr. George M. Hornberger, Vice-Chairman ACNW 11:00-11:20 a.m.

- Closing Remarks - NRC Chairman 11:20-11:30 a.m.

Attachments: As stated

cc: ACNW Members
ACNW Staff

ADVISORY COMMITTEE ON NUCLEAR WASTE
MEETING WITH
U.S. NUCLEAR REGULATORY COMMISSION

Rockville, MD
December 18, 1997

Advisory Committee on Nuclear Waste

Strategic Planning and Priorities for 1998

Dr. B. John Garrick
Chairman, ACNW

ACNW Mission

Provide independent and timely technical advice on waste management issues to support the NRC in conducting an efficient regulatory program that enables the Nation to safely use nuclear materials

ACNW Vision

The ACNW strives to provide advice and recommend solutions that are forward looking, based upon the best-available science and technology, can be implemented, and reflect the need to balance risk, benefit, and cost to society to enable the safe use of nuclear materials

ACNW Goals

- Assist the NRC in responding to change and uncertainty in the management of nuclear waste
- Provide assurance to the Commission that the best science is being employed in resolving key safety issues
- Provide advice to the NRC on how to increase its reliance on risk as a basis for decision-making including risk assessment methods for waste management
- Assist the NRC in improving public involvement
- Optimize effectiveness and efficiency of ACNW operations

Criteria to Select Priorities

- Protection of public health, workers, and the environment
- Issues requested for ACNW review by Commission
- Timeliness based on scheduled Commission review
- Relationship of issue to NRC Strategic Plan
- Potential for an issue to pose undue risk or cost to society
- Issues arising from strategies and activities of licensees
- Issues arising from technical basis for safety assessments

ACNW First Tier Priorities

- Viability Assessment
- Risk-Informed, Performance-Based Regulation
- Engineered Barrier System
- Decommissioning
- Research

ACNW Second Tier Priorities

- Repository Design
- HLW Interim Storage
- DOE Oversight
- LLW and Agreement States
- Radiation Risk Levels for Low-Level Ionizing Radiation
- Control and Accountability for Radioactive Devices

Applications of Probabilistic Risk Assessment Methods to Performance Assessment in the NRC High-Level Waste Program

Dr. B. John Garrick
Chairman, ACNW

Primary Issues

- Performance Assessments should follow the philosophy of risk assessment in developing realistic models that display the uncertainties

- The approach to Performance Assessment should allow the contributors to the performance of the repository to be transparent and rank-ordered

NRC Staff Accomplishments

- Revised NRC Total Performance Assessment code, version 3.1 (TPA-3), represents a pivotal effort

- Longstanding staff efforts to ensure:
  - the collection of appropriate site characterization information, and
  - the understanding of processes affecting repository performance

- Approaches for abstracting site and design information and process models into the TPA-3 model

Realistic Models

- Realistic models and parameters should be used so that the results of the PAs represent the full range of values that can be supported by the evidence
- Magnitude of the uncertainties is inversely proportional to the strength of the evidence
- Bounding analysis and worst-case calculations should be used primarily to screen out issues of little or no concern
- TPA-3 should be reviewed for unrealistic results that arise from bounding calculations embedded in the code

Interpretation of Results

- Key similarities of PRA and PA methodologies
  - Initial conditions and modular approaches
  - Decompose into logical pinch points
  - Specific performance measures

- PRA post-processing methodologies allow systematic and efficient unraveling of results into specific contributors to performance
  - Identify inputs and outputs of different modules in terms of contributions to overall performance
  - Event tree approaches can make the results more transparent and sharpen understanding of the total system model

Interpretation of Results (Cont.)

- An event tree or a similar approach should be developed and applied to evaluating TPA-3 model results

  - Staff should continue developing appropriate importance measures
  - Performance measures at specific pinch points in the analysis should be defined

Conclusions

- More realistic model assumptions and parameters will help in identifying where uncertainties are important to demonstrating compliance and assist in defending staff positions vis-a-vis magnitudes of uncertainties and degree of conservatism in analyses

- An event tree postprocessor will help identify the importance of Key Technical Issues to overall performance and in prioritizing resources

UNITED STATES
NUCLEAR REGULATORY COMMISSION
ADVISORY COMMITTEE ON NUCLEAR WASTE
WASHINGTON, D.C. 20555

October 31 1997

The Honorable Shirley Ann Jackson
Chairman
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555-0001

Dear Chairman Jackson:

SUBJECT: Application of Probabilistic Risk Assessment Methods to Performance Assessment in the NRC High-Level Waste Program

This letter provides the Commission with the Advisory Committee on Nuclear Waste's (ACNW's) observations and recommendations on the application of probabilistic risk assessment (PRA) methods to performance assessment (PA) in the High-Level Radioactive Waste (HLW) Program. We believe our recommendations enhance the Commission's policy of increasing the use of risk-informed, performance-based approaches in waste management. The Committee considers this issue a high-priority item because of the need for transparency and clarity[1] in the decision-making process, not only for the NRC's prelicensing and licensing activities for the proposed HLW repository at Yucca Mountain, but also for other waste-related activities, such as decommissioning, low-level waste management, and management of uranium mill tailings. The complexity of the proposed repository system at Yucca Mountain and the models that are intended to represent its performance over time necessitates some method for presenting the results that clearly indicates to the decision makers and to the public what the expected performance will be and what the main subsystem components are that contribute to that performance. The Committee firmly believes that certain PRA approaches can be successfully applied to the PA results for waste management.

Summary and Recommendations

In general, the Committee is impressed with the methods employed by both the NRC and the Department of Energy (DOE) in their work on PA. Analytically characterizing the performance of the proposed Yucca Mountain repository involves an unprecedented application of physical process modeling and probability methods. The progress in abstracting site characterization and facility design information into probabilistic PA (PPA) models has been extensive.

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[1] By "transparency" we mean the ability to see through the entire process, to understand the process; by "clarity" we mean the ability to discern the key elements in the analyses.

Despite this considerable progress, the Committee does have some concerns about the staff's PA program. These concerns center around two primary issues. The Committee believes that PAs should follow the intent and spirit of the risk-assessment philosophy of developing realistic models with uncertainties included, as opposed to developing bounding or worst-case calculations. We also believe the assessments should enable unraveling the results into rank-ordered contributors to the overall risk or to the performance of the repository. The latter provides a solid basis for developing confidence in the design and meaningful risk-management practices.

Therefore, we recommend the following:

- To as great an extent as possible, realistic models and parameters should be used so that the results of the PAs represent the full range of values (i.e., upper and lower bounds, central tendency parameters, and the values in between) that realistically can be supported by the evidence.

- Bounding analysis and worst-case calculations should be used primarily to screen out issues of little or no concern, i.e., to scope the analysis, but not to be the basis for generating results that are clearly out of context with reality and, thus, that do not produce a framework for judging reality.

- The NRC Total Performance Assessment code, version 3.1 (TPA-3), should be reviewed for unrealistic results that arise from bounding calculations embedded in the code. Ultraconservative model assumptions and parameter values should be replaced with more realistic assumptions and probability distributions.

- An event tree or a similar approach for evaluating the TPA-3 model results emphasizing the systematic and efficient unraveling of results into specific contributors to performance should be developed and applied.

- Appropriate importance measures should be developed. We understand that staff from both the NRC and the Center for Nuclear Waste Regulatory Analyses (CNWRA) are currently working on this issue. The Committee encourages the continuation of this effort.

- Subsystem performance measures at specific pinch points[2] in the analysis, such as the flux of radionuclides released from the repository into the geosphere, should be defined. These performance measures might include the integrated release of radionuclides over time, or the release rate as a function of time. Both the NRC and DOE have indicated that their respective models are capable of providing intermediate results (e.g., source term output to the geosphere). Hence, the approach can take advantage of the existing model subsystem output capabilities.

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[2] Pinch points occur where outputs (material, energy, or information flow) from one module of the total system model become the inputs to another module.

Background

The comments in this letter have been developed, in part, on the basis of a working group meeting on the application of PRA methods to PA during the 93rd ACNW Meeting at the CNWRA in San Antonio, Texas, on July 24, 1997. Participants included representatives from: the PRA field; the Electric Power Research Institute; the DOE's Yucca Mountain Project; the Waste Isolation Pilot Plant PA Project; and the NRC staff. The Committee benefited from detailed NRC staff presentations on the HLW PA program and the NRC's TPA-3 code during the previous day's ACNW meeting on HLW PA capability. The Committee members and staff also observed the NRC/DOE technical exchange on DOE's Total System Performance Assessment activities and NRC's iterative performance assessment (IPA) efforts on July 21-22.

Accomplishments

The NRC staff's work on the revised TPA-3 code represents a pivotal effort. The staff has made longstanding, extraordinary efforts to ensure that appropriate site characterization information is collected and to understand the processes that ultimately may determine the performance of an HLW repository at Yucca Mountain. As part of the IPA program, the staff has developed approaches for abstracting site and design information and process models that have been incorporated into the TPA-3 model. The Committee commends this effort and notes that the recommendations previously presented are aimed primarily at developing more realistic models, mainly with respect to assumptions and scope, and improvements in processing the information that is the current output of the TPA-3 model. In particular, the Committee is not suggesting basic changes in the model but is encouraging more realistic assumptions and improvements in the methods for analyzing the results of the PAs.

Realistic Models

Probabilistic concepts have their greatest value in communicating confidence in the outcome of an event or process. They provide the tool for analysts to express their full state of knowledge about how likely an event or process is. The introduction of probabilistic analysis does not replace the deterministic models; rather, it allows a richer interpretation of results. Of course, the probabilities must be supported with appropriate evidence, and to the extent that the evidence is weak, the uncertainties are greater. Such communication is the essence of probabilistic analysis. Thus, the aim of PPA should be to "tell it like it is" on the basis of all the evidence available. The result is what the experts and, with public participation, society believes is likely to happen. A logical framework then exists to make decisions as conservative as desired, but within a framework that defines the level of conservatism.

Interpretation of the Results

Although there are clear differences between nuclear power plant PRAs and waste system PAs (which have been discussed with the Commission by both the NRC staff and the ACNW), a number of key similarities makes it possible to consider the use of PRA methods, such as the top-down event tree approach, to facilitate interpretation of PA results. Both PRAs and PAs

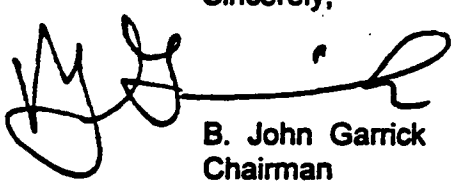
begin with a set of initial conditions (in PRAs these are called initiating events). In PAs, the initial conditions may consist of such phenomena as climate conditions, volcanic events, seismic events, or human intrusion. Both PRA and PAs use a modular approach to the analysis (in PRAs, this includes level-I, -II, and -III analyses; in PAs this includes analyses for infiltration, engineered barriers, source term, geosphere transport, biosphere uptake, and dose to the critical group). Both methodologies can be decomposed into logical pinch points for which specific performance measures can be developed (such as core damage for PRA and integrated release of radionuclides into the geosphere for PA). The goal is to develop a systematic and efficient method for identifying different inputs and outputs of the various modules that make up the full PA model in terms of their individual contribution to the overall performance of the repository. To do this may require a different approach in the way that scenarios are structured for PA.

At our workshop, candidate methods were presented for systematically and efficiently interpreting the results from PAs using a post-processing tool, such as an event tree approach. The postprocessor could make the results more transparent and sharpen our understanding of the total system model. The Committee believes that these techniques should be explored for TPA-3.

An important benefit of the proposed approach to interpreting PA results should be with respect to the program for evaluating key technical issues (KTIs). The postprocessor should greatly facilitate the task of determining the importance of individual KTIs to the overall performance of the repository. This will allow staff to allocate already scarce resources to the KTI program so that the focus is on the most important KTIs and subissue areas. The approach will also prove useful in determining where uncertainties are important to demonstrating compliance and where they do not really matter, even if they are large. Sometimes there is a tendency to focus only on the relative magnitude of the uncertainty in a model or parameter (large uncertainty is considered bad and small uncertainty is considered good), rather than on whether that uncertainty makes any significant difference to the bottom-line result, which is ultimately the health and safety of the public. The goal in the near term would be to avoid spending large resources on trying to reduce uncertainties that do not matter to the result. In the longer term, the goal is to be able to defend in a licensing hearing the specific staff positions in the safety evaluation report vis-a-vis the magnitudes of the uncertainties for different subsystems and for total system performance.

The Committee looks forward to following the staff's program in PA, and we are particularly interested in its progress on the two issues of transparency of results and the use of realistic models.

Sincerely,



B. John Garrick
Chairman

Comments on

Performance Assessment Capability in the

NRC High-Level Radioactive Waste Program

Dr. Raymond G. Wymer
ACNW

NRC Staff Accomplishments

- Upgrading and preserving a dedicated HLW PA team
- Organizing the HLW Program around KTIs -- focusing staff's efforts on issues most important to performance of the repository
- Integrating across disciplines in KTIs and setting priorities
- Developing sound, near-term plans for prelicensing activities, including resolving outstanding issues

NRC Staff Accomplishments (Cont.)

- Preparing for review of DOE's total system performance assessment -- viability assessment (TSPA-VA)

- Revising and updating TPA-3 code to increase staff's capability in performing assessment modeling

  - Evaluating the importance of site characteristics
  - Evaluating the contribution of engineered barriers

Engineered Barrier System

- Concerns
  - Reduction of CNWRA efforts on KTIs related to engineered barriers and radionuclide transport
  - Sufficiency of the PA effort, including TPA-3 code, to adequately assess DOE activities

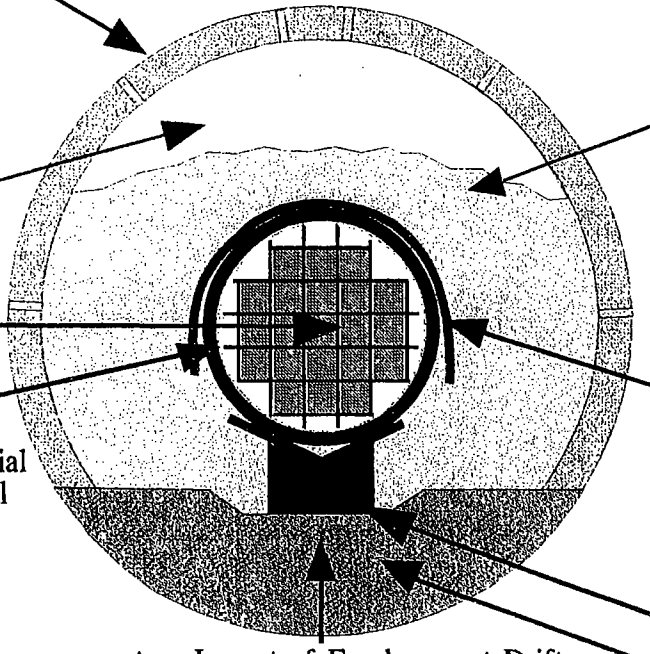
- Needs
  - General

    Staff capability to analyze the design of long-term, passive, high-integrity systems
  - Specific

    engineering analysis
    materials science
    chemistry

Engineering Features Being Considered by DOE for Yucca Mountain HLW Repository

Design Options for Waste Isolation (Design Features Evaluation)



Thermal Design
- ◆ ★ Areal Mass Load (High)
- ◆ ★ WP Spacing (Point)
- SNF Assembly Blending
  - ★ To meet 18 kW limit
  - To meet criticality limit
- WP Sequencing
  - ★ 4-Drifts Open

Drift Liner
- ★ Normal Concrete

Backfill
- ★ Rock Fall Protection

Air Gap
- ◆ ★ (Capillary Barrier)

- ◆ Cladding Credit

Drip Shield
- ◆ ★ Supported by WP

Waste Package
- ◍ Corrosion Allowance Material
- ◍ Corrosion Resistant Material
- ◍ Galvanic Protection
- ◍ Ceramic Coating (Outside)
- ◍ Large
- ★ In-drift Emplacement

- ◆ ★ Pedestal
- ▲ Invert

- ▲ Layout of Emplacement Drift Sloped

- ▲ Zeolites

★ Limit WP Environment
◍ Robust WP
◆ Limit Mobilization
▲ Radionuclide Concentration Reduction

09/22/97 11:00 am
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Requirements of Realistic Performance Assessment Models

- PA models should be structured to represent repository performance as realistically as possible
- Supporting evidence should be collected, organized, and documented
- Abstracting process models into probabilistic models should be clear and transparent
- The scientific basis for treatment of phenomena leading to mobilization of radionuclides in the near field should be enhanced

Conclusions

- Staff's work on the TPA-3 code represents a solid effort and ACNW is pleased that a working code has been implemented

- Further needs include:
  - Verification and benchmarking of TPA-3
  - Obtaining extensive and timely peer review of codes
  - Maintaining adequate computer capability

- Selected capabilities should be added to the program to help assess the containment capacity of the engineered systems

- The ACNW is glad to see the restoration of support at CNWRA for radionuclide transport and engineered barrier KTIs

UNITED STATES
NUCLEAR REGULATORY COMMISSION
ADVISORY COMMITTEE ON NUCLEAR WASTE
WASHINGTON, D.C. 20555

October 8, 1997

The Honorable Shirley Ann Jackson
Chairman
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555-0001

Dear Chairman Jackson:

SUBJECT: Comments on Performance Assessment Capability in the NRC High-Level Radioactive Waste Program

The purpose of this letter is to advise the Commission about the NRC staff's performance assessment (PA) capability in the High-Level Radioactive Waste (HLW) Program. Performance assessment is an important tool in NRC's prelicensing activities, including the following: understanding the importance of specific site characteristics and the design of engineered features to the performance of an HLW repository at Yucca Mountain, prioritizing key technical issues (KTIs) and staff activities, developing revised standards and regulations for licensing, and preparing for review of the Department of Energy's (DOE's) viability assessment (VA) of the proposed repository. The evaluation of staff HLW PA capability continues to be a priority issue of the Advisory Committee on Nuclear Waste (ACNW).

The observations and comments in this letter have been developed, in part, on the basis of the 93rd ACNW Meeting at the Center for Nuclear Waste Regulatory Analyses (hereafter the Center) in San Antonio, Texas, on July 23-24, 1997. The ACNW previously reviewed and commented on staff HLW PA capability in letters dated December 2, 1991, and May 27, 1994.

Recommendations

The Committee makes the following recommendations:

- Selected capabilities should be added to the program to provide further assurance that the staff has the ability to assess the containment capacity of the engineered systems. Support for KTIs relating to the near-field performance of the repository should be restored. Among the disciplines for which the ACNW believes added capability is necessary are engineering analysis, materials science, and chemistry. The crosscutting discipline of corrosion science and engineering is also an essential part of the mix.

- The PA models should be structured to represent repository performance as realistically as possible and thereby provide the necessary information for regulators to make decisions in the context of the full state of knowledge about the performance measures of the repository. Improved coordination and communication between the NRC staff and the Center will be essential.

- Greater emphasis should be given to collecting, organizing, and documenting the supporting evidence for the performance assessments to enhance acceptance of the results. An important element of this is improvement in communicating the abstraction of process models into probabilistic models. Of particular interest to the Committee is visibility of the treatment of such phenomena as chemical and geological processes leading to the mobilization of radionuclides in the near field.

- A working version of the NRC's Total Performance Assessment code, version 3.1 (TPA-3) should be implemented as soon as practicable.

- A program for verifying TPA-3 should be developed. TPA-3 should be benchmarked against other codes for Yucca Mountain. The Committee also encourages exposure of the methods of TPA-3 and associated background information to the scientific community through extensive and timely peer review.

Accomplishments

The Committee commends the staff for its many impressive accomplishments in upgrading and preserving a dedicated HLW PA team in the face of budget cuts and programmatic uncertainties. The organization of the HLW Program around a specific set of KTIs and the grouping of expertise and disciplines within the KTIs provides an important means of focusing the staff's efforts on issues most important to performance of the repository. Performance assessment is important in the staff's efforts to provide integration across disciplines in the KTIs and to set priorities for activities. The Committee was pleased to see the clear integration of PA with other Yucca Mountain activities. This effort has led to the development of sound, near-term plans for prelicensing activities, including resolving outstanding issues and preparing for review of DOE's total system performance assessment supporting the viability assessment (TSPA-VA). The revised and updated TPA-3 code increases the staff's capability in performance assessment modeling. The code should facilitate the KTI investigations with its ability to evaluate the importance of specific site characteristics and the effectiveness of engineered barriers. The ability to conduct sensitivity and uncertainty analyses for subsystems and for the total system is improved. The development of the code is a solid effort and we encourage the staff to pursue aggressively the implementation of TPA-3. Many of these staff activities conform to recommendations contained in the ACNW letter of May 27, 1994, on PA capability.

Engineered Barrier System

The ACNW is concerned about the staff's capability to evaluate quantitatively the engineered barrier system of the proposed Yucca Mountain repository. This concern is punctuated by lessons learned from PA, including the apparently increasing dependence on engineered barriers to demonstrate compliance with a dose- or health-based standard for the repository. With increasing evidence that engineered systems must be an important part of the waste isolation strategy for Yucca Mountain, it is important that these systems receive extensive scientific and engineering scrutiny.

We are concerned about the decision to reduce the effort at the Center on certain KTIs, most

notably those dealing with engineered barriers and radionuclide transport. The shifting emphasis of the DOE to the performance of engineered systems accents the need for the Commission to provide resources to restart work on the KTIs most important to an independent assessment of the performance of engineered systems and near-field radionuclide transport. A concern is that without restarting the work of the NRC staff and the Center, the performance assessment effort, including the TPA-3 code, will not have the scope to assess adequately the DOE work. The Committee urges the Commission to act on this issue as soon as practicable.

Beyond the issue of the scope of the engineered systems assessment capability of the NRC staff, the ACNW believes that added capability is necessary to analyze adequately the engineering design of long-lived, passive high-integrity systems. In particular, additional staff effort is required in engineering analysis, materials science, and chemistry (especially corrosion and colloid chemistry) to have the full capability to assess the engineered systems.

Realistic Performance Assessment Models

The ACNW has three primary points to make regarding the staff's performance assessment modeling activities: (1) the PAs should have a risk-informed perspective; (2) the PAs should be transparent about the supporting evidence (data and information); and (3) the relationship between process model and probabilistic calculations needs to be made clear.

Risk-informed performance assessment provides the opportunity to assess *realistically* the performance of an HLW repository. Our concern is that the TPA-3 activity is relying too much on bounding and worst-case calculations. Although bounding calculations are a very useful part of any technical investigation in providing insights on what is important to the performance measures of a model, such calculations are often of little value in representing what is likely to happen. In the opinion of the ACNW a much preferred approach is to limit bounding and worst-case calculations to the task of scoping the investigation and deciding what may or may not be important to model. Decision making requires more information. The decision-maker needs to know the total range of uncertainty of the performance measures. The primary tool for communicating uncertainty, rather than just an upper bound, for example, is to embed the performance measures in probability distributions so that the full range of values and all their supporting evidence are visible. For example, if the value preferred by the regulator is the 90th percentile value, then it is explicitly clear just how conservative the regulator has chosen to be.

The Committee stresses the importance that the evidence (i.e., data and all other information) that is the basis of the PA model be clearly visible, particularly regarding the abstraction from physical process models to probabilistic calculations. We are especially concerned with the abstraction of information about the engineered systems, especially under the circumstances of not having a fixed design. In addition, supporting evidence for modeling important phenomena such as the chemistry of redox reactions is weak. Our current impression is that more attention is being given to methods than to the required information to support those methods.

Analysis Capability

The ACNW was impressed with the progress in the development of NRC's TPA-3 code. We are anxious to follow the development of TPA-3 and look forward to more discussions with the staff.

The ACNW urges the staff to implement a working code in an expeditious manner so that the code is fully functional as the TSPA-VA analyses are made available to NRC.

The Commission has indicated an interest in moving toward a risk-informed, performance-based philosophy of regulation. Of concern to us is whether the TPA-3 effort is keeping pace with the development of methods and ideas on how to implement such a philosophy.

An issue with TPA-3 is how to verify the code. The problem as stated by the staff is that because the code is designed specifically for the Yucca Mountain site, international bench marking is almost impossible. It is true that parts of the code, such as NEFTRAN (NEtwork Flow and TRANsport), have been benchmarked. The NRC staff must see that TPA-3 is benchmarked against applications of other codes to Yucca Mountain. The ACNW also believes that the NRC staff should pursue other avenues of peer criticism of its codes, such as publication in refereed engineering and scientific journals.

Although the ACNW believes that it is important to develop a PC compatible version of the code to reach more users, we would not like to see other important activities compromised to reach this goal. A PC compatible version should not be created at the risk of oversimplification. Meanwhile, to conduct a full range of analyses in reviewing DOE's TSPA-VA, the staff requires the NMSS Advanced Computer System or a suitable alternative.

We believe that these comments provide constructive guidance on the future direction of the performance assessment effort and look forward to following NRC staff progress in this important activity.

Sincerely,

B. John Garrick
Chairman

Recommendations Regarding the Implementation of the Defense-in-Depth Concept in the Revised 10 CFR 60

Dr. George M. Hornberger
Vice-Chairman, ACNW

Introduction

- October 31, 1997 letter recommends an approach for implementing the defense-in-depth (DID) concept in the revised 10 CFR 60 for Yucca Mountain

- Approach is risk-informed, thus eliminates need for subsystem requirements for ground water travel time, radionuclide release rates, and waste package lifetime

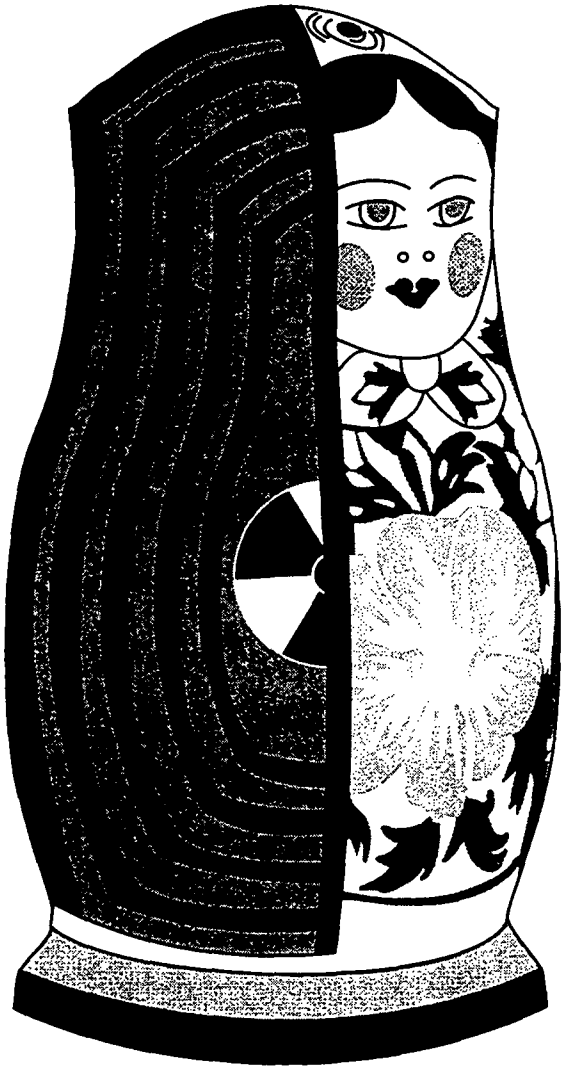
- Overall performance-based regulation in the context of a risk-based standard is a superior tool for promoting safety relative to imposed subsystem requirements and allows for greater opportunity for public involvement

Background

- ACNW does not support the concept of rule-based, prescriptive subsystem requirements as exist in 10 CFR 60, which can lead to suboptimal design

- ACNW endorses the concept of DID and recognizes the need for reliance on diverse barriers as part of DID

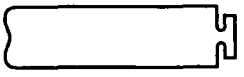
- ACNW supports the concept in 10 CFR 60 that both the engineered portion of repository and the natural setting must each make a definite contribution to waste isolation



Source: Chapman, N. A. et al. *The Geological Disposal of Nuclear Waste.* J. Wiley & Sons Ltd. 1987.

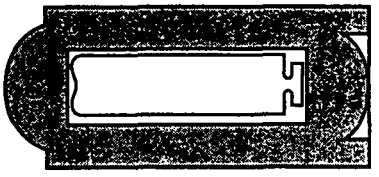
THE SYSTEM OF SAFETY BARRIERS FOR HIGH-LEVEL WASTE

Glass matrix (molecular distribution)



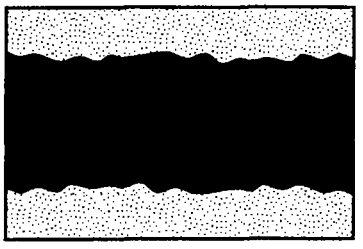
- Restricts release

Steel canister (corrosion-resistant



- Retards water penetration
- Provides favorable chemistry

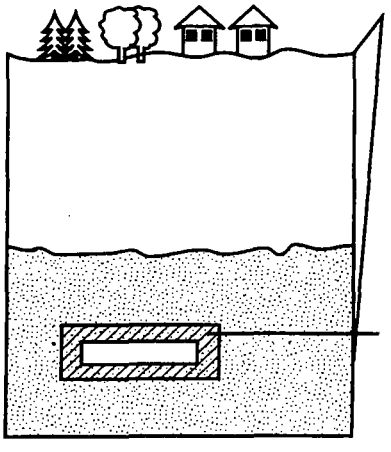
Bentonite-clay (compacted, capable of swelling)



- Restricts water penetration
- Delays commencement of release (diffusion break-through time)
- Restricts release (diffusion)

Sedimentary overburden

Host rock



Geosphere

- Long water-flow times
- Additional retardation of radioactive material transported in water (sorption, matrix diffusion)
- Long-term stability of hydro-geological conditions in view of climatic and geological changes

Repository Zone

- Limited water supply
- Favorable chemistry
- Geological long-term stability

Source: Chapman, N. A. et al. *The Geological Disposal of Nuclear Waste.* J. Wiley & Sons Ltd. 1987.

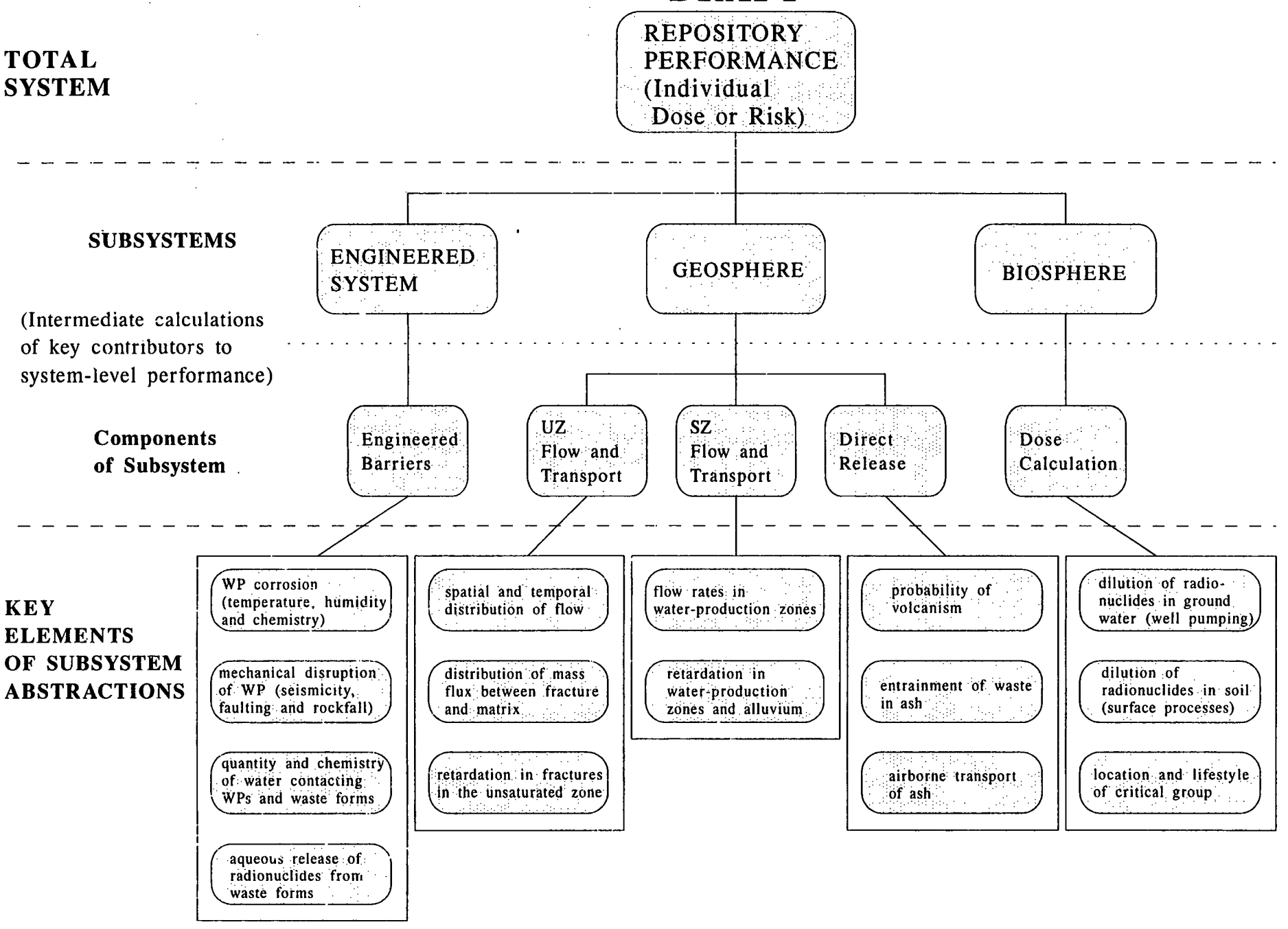
Recommendations

- Recommend using performance assessment to quantify the effectiveness of individual barriers, relationships between barriers, and uncertainties in barrier performance

- Require DOE to demonstrate that both the geological system and the aspects of the engineered system are effective in providing waste isolation capacity and how each barrier contributes to meeting the overall safety objective

- NRC should set forth sound principles for guiding the implementation of DID in revised 10 CFR 60

DRAFT



NRC Staff Diagram for Total System Performance Assessment

Conclusion

- Approach allows for taking advantage of site and design specific properties and features; clarifies the degree of dependence of the overall performance of individual barriers; and exemplifies risk-informed, performance-based regulation

UNITED STATES
NUCLEAR REGULATORY COMMISSION
ADVISORY COMMITTEE ON NUCLEAR WASTE
WASHINGTON, D.C. 20555

October 31, 1997

The Honorable Shirley Ann Jackson
Chairman
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Dear Chairman Jackson:

SUBJECT: RECOMMENDATIONS REGARDING THE IMPLEMENTATION OF THE DEFENSE-IN-DEPTH CONCEPT IN THE REVISED 10 CFR PART 60

This letter communicates the recommendations of the Advisory Committee on Nuclear Waste (ACNW) for adopting a revised approach to the existing subsystem performance criteria in 10 CFR Part 60, "Disposal of High-Level Radioactive Wastes in Geologic Repositories," to implement the defense-in-depth (DID) concept.

RECOMMENDATIONS

1. The Committee endorses the concept of defense in depth, including institutional as well as structural aspects. In particular, we recognize the benefit of multiple barriers of protection. The Committee recommends that sound principles be set forth guiding the implementation of the concept of defense in depth. The Committee, however, does not endorse the establishment of rule-based subsystem requirements as exist in 10 CFR Part 60.

   We believe that guidance will depend to a large extent on proper construction of a performance assessment (PA) to expose the role of design elements, operational elements, and multiple barriers, including interdependency of the multiple barriers. The regulations should be clear on how the DID concept should be implemented. The Department of Energy (DOE) (or any future license applicant) should be directed to furnish documentation that shows how the DID concept has been implemented in meeting the overall performance goal.

2. The Committee recommends that NRC performance assessment procedures be structured so that the effectiveness of individual barriers can be identified explicitly in the total system performance.

   The PA should clearly expose the effectiveness and role of selected individual barriers such as the engineered systems and the natural geological setting. The assessment of individual barriers should include a quantification of the uncertainties involved and the inter-relationships among barriers. The Committee believes that there are methods for quantifying the role of individual engineered barriers and the containment capability of the natural setting. To achieve the capability to assess the effectiveness of individual barriers, both geological

and engineered, it may be necessary to modify the analysis methods, including the PA models, and to enhance the database to reveal the performance of individual barriers. The Committee also believes that exposure of the public to a PA process that is sufficiently transparent could lead to improved public confidence in the ability of the repository to isolate waste effectively.

This letter is one in a series of letters to the Commission conveying the ACNW's views on aspects of the NRC staff's strategy for revising 10 CFR Part 60. Previous letters on the staff's strategy for revising 10 CFR Part 60 include "Issues and NRC Activities Associated with the National Research Council's Report, 'Technical Bases for Yucca Mountain Standards,' " February 9, 1996; "Time Span for Compliance of the Proposed High-Level Waste Repository at Yucca Mountain, Nevada," June 7, 1996; and the "Reference Biosphere and Critical Group Issues and Their Application to the Proposed HLW Repository at Yucca Mountain, Nevada," April 3, 1997. Our recommendations are formulated on the basis of presentations made to the Committee during the 90th, 91st, 92nd, and 93rd meetings by the NRC staff, the DOE staff and its contractors, the State of Nevada, the National Research Council, and representatives from industry, as well as on the basis of the Commission's policy on risk-informed, performance-based regulation.

The Nuclear Waste Policy Act of 1982, as amended, mandates NRC to develop technical criteria for HLW disposal that are consistent with the Environmental Protection Agency (EPA) generic standards and provide for a system of multiple barriers. The Energy Policy Act of 1992 mandates that NRC conform its regulation to the final EPA standards for Yucca Mountain, the latter of which are to be based on and consistent with recommendations made by the National Academy of Sciences' Committee on Technical Bases for Yucca Mountain Standards (TBYMS). As directed by the Commission, the NRC staff is currently pursuing development of site-specific regulations for Yucca Mountain to implement the forthcoming EPA site-specific standards for Yucca Mountain.

In this letter, the concept of DID refers to the methods of design, construction, and operation of a geological repository for HLW in ways that aim to ensure safety in the face of considerable uncertainty in our knowledge of various processes. The implementation of DID in the repository context entails an analysis that exposes the contribution of each design element, each process (or set of processes) in the natural geological setting, and each operational technique to the safety of the repository. The DID concept includes (but is not identical to) the notion of multiple barriers that act to isolate the waste. One of the major issues regarding regulation within the DID framework is whether and how prescriptive requirements (so-called subsystem requirements) should be placed on classes of these barriers. As discussed below, the Committee believes that the adoption of a risk-informed approach eliminates the need for prescriptive subsystem requirements for Yucca Mountain.

The present form of 10 CFR Part 60 partly implements the DID approach by prescribing performance requirements of particular barriers.[1] As noted in the Statement of Considerations to 10 CFR Part 60, in addition to the natural barrier provided by the geological setting, this multiple barrier approach identifies two engineered barriers: the waste package and the underground facility. The Statement of Considerations notes that the multiple barrier concept is implemented by the performance objectives or requirements, as well as by more detailed siting and design criteria. The Committee

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[1]Paraphrasing the regulation, the performance requirements specify substantially complete containment of waste packages for 300 to 1,000 years after permanent closure, release rates of radionuclides from the engineered barrier system less than one part in 100,000 per year at 1,000 years after closure, and a prewaste-emplacement groundwater travel time of at least 1,000 years.

recognizes that inclusion of the quantitative subsystem performance requirements in the rule was thought to provide additional confidence to compensate for uncertainties associated with predicting the behavior of a repository over thousands of years and for the general lack of experience and confidence in analyzing repository performance.

The Committee supports the NRC's view expressed in the Statement of Considerations to 10 CFR Part 60 that the performance of the engineered portion of the repository and the geological system must each make a definite contribution to waste isolation. The Committee recognizes the need for reliance on multiple and diverse barriers as part of the DID concept. However, we do not endorse the implementation of the DID concept through inclusion of prescriptive subsystem criteria in the revised 10 CFR Part 60.

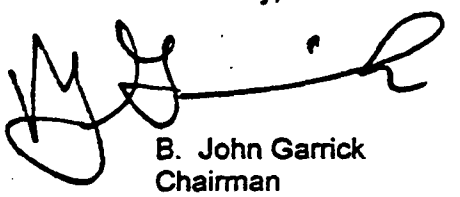
Current thinking, which is supported by much experience and empirical evidence in both probabilistic performance assessment and site characterization is that performance-based regulations are much more efficient and effective in protecting health, safety, and the environment than are "command-and-control" approaches. Focusing on quantitative subsystem requirements for the proposed repository at Yucca Mountain would run counter to this thinking because it potentially could force a design that would increase overall risk even though all subsystem requirements were met. A hypothetical example may clarify: a requirement that backfill in the repository be capable of substantially retaining all radionuclides leached from the waste package for 1000 years might be imposed. Such a requirement, which on the surface could be seen as beneficial, might force a design that would diminish significantly the lifetime of the waste canister by changing geochemical conditions in the near field. The outcome could be an increased risk to affected populations relative to a repository without backfill. It is this type of potentially adverse effect from subsystem requirements that an overall performance-based regulation would avoid. Consideration of such hypothetical examples supports our main conclusion that an overall performance-based regulation in the context of a risk-based standard is a superior tool for promoting safety relative to imposed subsystem requirements.

A major problem with the current version of 10 CFR 60.113, "Performance of Particular Barriers After Permanent Closure," which prescribes performance of particular barriers, is that it is not clear just how relevant any subsystem performance requirement is to the overall safety performance of the repository. Furthermore, in the analysis of repository performance, interdependency of barriers makes it difficult to assess precisely the role of individual barriers. For example, the assumed rate of percolation of water through the repository affects the performance of all subsystems. The connection between barrier performance and overall performance is very site- and design-specific. Prescribing individual barrier performance may create a design that is imbalanced in terms of individual barrier effectiveness. Subsystem requirements may also result in very poor designs from an economic standpoint. The ACNW's view is consistent with the TBYMS report, which cautioned against imposing subsystem requirements that may inadvertently result in a suboptimal repository design.

The primacy of an overall performance-based regulation does not imply that DOE, as the license applicant for Yucca Mountain, would not have to demonstrate convincingly to the NRC that both the geological system and multiple aspects of the engineered system were effective in providing waste isolation capacity. The NRC should insist that the applicant's PA clearly and quantitatively indicates how each barrier contributes to meeting the overall safety objective. This information should provide the basis for an informed decision on the license application.

The approach that we recommend offers many advantages over prescriptive subsystem requirements. First, it allows taking maximum advantage of site- and design-specific properties and features. Second, it is a clear example of risk-informed, performance-based regulation. The important contributors to risk can be ranked, thus providing a basis for prioritizing design changes and risk management activities. Third, it clarifies the degree of dependence of overall repository performance on individual barriers. In a sense, the safety margins of the various barriers are made more explicit through quantification.

Sincerely,



B. John Garrick
Chairman