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UNITED STATES NUCLEAR REGULATORY COMMISSION'S

ADVISORY COMMITTEE ON NUCLEAR WASTE

December 13, 2004

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UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

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ADVISORY COMMITTEE ON NUCLEAR WASTE (ACNW)

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156th MEETING

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MONDAY

DECEMBER 13, 2004

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ROCKVILLE, MARYLAND

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The Advisory Committee met at the Nuclear Regulatory Commission, Two White Flint North, Room T2B3, 11545 Rockville Pike, at 4:00 p.m., Dr. Michael T. Ryan, Chairman, presiding.

MEMBERS PRESENT:

MICHAEL T. RYAN	Chairman
ALLEN G. CROFF	Vice Chairman
JAMES CLARKE	Consultant
WILLIAM J. HINZE	Consultant
RUTH F. WEINER	Member

ACNW STAFF PRESENT:

NEIL M. COLEMAN

JOHN FLACK

LATIF HAMDAN

HOWARD J. LARSON

MICHAEL LEE

RICHARD K. MAJOR

AGENDA ITEMS PAGE

P R O C E E D I N G S

(4:04 p.m.)

CHAIRMAN RYAN: Okay. We'll reconvene, it now being four o'clock. And next up is a presentation on time of compliance for a proposed high-level waste repository. And Bill, you're going to give us the presentation.

DR. HINZE: Very good. And there are slides that go along with this so if you don't understand me, hopefully you'll be able to understand the slides.

And I do want to certainly thank Mike Lee of your staff who has worked diligently to bring me up to speed, especially on those topics that have occurred in time of compliance since I left the Committee.

The whole issue of time period of compliance for geological repositories has been a controversial and a problematic issue for at least 25 years. It's been around and it's raising its -- I shouldn't say ugly -- head once again.

If I may have the next slide. This is an outline of the presentation or discussion that we're having here today.

What I'm trying to do is to lead you to

the previous ACNW views and recommendations. We'll be looking at the basis for the time-of-compliance, the Energy Policy Act of '92, which then set up the National Academy Technical Basis Study which was reported in '95. And then response of the EPA and the DOE. And then the more recent court remand.

We'll say a few words about national and international perspective. And I'm going to conclude with some personal observations that hopefully will be of interest to the Committee. And the Committee may wish to consider what its role will be in time-of-compliance from here on.

Then may I have the next slide please. There are many ways that we can define this time period of regulatory compliance but there are three essential ingredients to it. There's the minimum time that has to be, the time over which the repository must comply with the standard, and the critical group. Those are the REMI.

One way to express this is that it is the minimum time period over which the repository must meet the dose limits or risk to the reference biosphere and the critical group. And this is following an established repository standard.

We have had different types of time-of-

compliance. If we go back to the late 70s, the early 80s, it was really a comparative time-of-compliance, more or less looking at the safety factor in the repository.

This, then, developed into a generic time-of-compliance in 191 and 60. And more recently, in the more recent CFRs of the EPA and the NRC, in a repository-specific time-of-compliance.

Now when I started to bring together materials that we might discuss, I thought about what are the criteria employed in setting a time-of-compliance. And in reading the documents, I could not find a listing of the time-of-compliance. So I took the liberty, if you will, to go through and -- next slide please -- and look at the CFRs and try to dig out the criteria.

First is that the time period has to be sufficient that we ensure the safety of humans and the general biosphere environment from a loss of integrity of all of the barriers of the repository.

Closely aligned with that is that we should have an adequate time -- this time period should be adequate so that we incorporate those processes and event which are going to impose the greatest risk, that are going to be important. And

generally I interpret this as being more geological factors.

The opposite side of the coin is that the period of time should be short enough, should be restricted to a time period in which the uncertainties can be prescribed with reasonable assurance so that the uncertainties don't become too great.

The fourth criteria, which I look upon as kind of a de facto criteria because it's used as a justification, for example, in the EPA 191, is that there should be sufficient time in this time-of-compliance that the source term has been drastically decreased and is roughly equivalent to the hazard that would be imposed by a hypothetical equivalent ore body.

If I could have the next slide please. And fortunately there is NUREG-1538 that was authored by our own Mike Lee and Tim McCartin and it has some interesting diagrams in it, which relate to this equivalence in 10,000 years, which was established in this generic time-of-compliance.

And the diagram on your left, which you can't read but hopefully you'll be able to look at in the original NUREG, shows the radionuclide hazard from the spent nuclear fuel. The initial products are

primarily fission products, gradually going to the natural products.

And on the right we have -- and I apologize you can't read that but the horizontal scale is from 10 to the first to 10 to the eighth. And what we see is the, if you will, the radionuclide hazard, the radioactivity from the spent nuclear fuel to the natural ore body.

And by the time we have reached something like 10,000 years, we're within -- the spent nuclear fuel is of the order of the radioactivity from a natural ore body of equivalent uranium content.

Thank you. Good. I'll try not to shine it in anyone's eye.

If I might have the next slide please. But then we go to the specific repository. And we have the generic repository criteria that we've just gone through. And then we have all of those things that are involved in the performance assessment of a specific repository, including the REMI or the critical group.

And we can't list these all but we all know what they are: source, inventory, waste form, nature, level of activity, and rate of change -- that's important -- of various geological, tectonic,

et cetera factors, underground igneous, location, nature, and evolution of the biosphere and the critical group. That is all, of course, part of the criteria of a specific repository.

There are two other criteria here that we've seen discussed related to Yucca Mountain and that is regulatory consistency. That's a paradigm that we would like to see invoked. And we look for this on a national and international basis. And then we also look at this in the low-level waste, the WIPP, the RCRA requirements for injection wells.

The interesting thing is that if you -- I have not studied this in depth but what I've been able to look at here in the last week or so is that these low-level waste is now being recommended by the NRC as 10,000 years. WIPP is 10,000 years.

We can't really say that this is regulatory consistency because this is a big circular action because many of these were really taken from the 10,000 years going back to the early consideration of 191. So the consistency argument might be misleading.

And finally, the specific repository should be -- whatever that means -- simple and understandable. It has to be something that is going

to be easily regulated. It's going to have to be understood by the various components that are reviewing the documents.

Next slide please. And then along came the Energy Policy Act of '92, which told the EPA and the NRC to develop new radiation standards and repository regulations and specifically to do this for the Yucca Mountain site.

A second aspect of this was that the Energy Policy Act of '92 said you have to go to the National Academy of Sciences to advise you, the EPA, on the appropriate technical basis for the radiation standards.

Next slide please. And as a result of that, the Technical Basis Panel was set up, spent a couple of years chatting with each other and picking up a lot of useful information, and they presented a number of conclusions.

And their principle conclusion, and certainly one of their more controversial conclusions, is, with respect to the existing 10,000 year time-of-compliance, which had been established for the generic repository in 191 and 63.

And there are three elements of their conclusion regarding time-of-compliance. First of

all, they stated that there was no scientific basis for limiting the time period of the individual risk standard to 10,000 years or to any other value. And, of course, this was what was strongly emphasized in the remand a few months ago.

Compliance assessment, they also made the argument that it is possible to bound the assessment for most physical and geological aspects on the time scale of a million years.

Again, this was for one of the more tectonic, dynamic areas of the world in comparison to the, for example, the Canadian Shield, but they said that they could predict for a million years.

And this had a caveat really, that the compliance assessment be conducted for the time when the greatest risk occurs. But it had this caveat within the limits imposed by the long-term stability of the geological environment.

That was one of the positions, one of the statements that gave the EPA and the NRC some opportunity to move around.

Next slide please. And the net result is that on policy grounds and also with this caveat of the long-term stability, if you will, we have ended up with a 10,000 year time-of-compliance now not just for

the generic but also for the specific Yucca Mountain. And this, of course, has now been remanded.

If I may have the next slide please. Currently, of course, and over the past couple of decades, the DOE and the NRC and others have conducted Yucca Mountain-specific performance assessments. And at least the DOE and NRC have considered this 10,000 year time-of-compliance.

Incidently, it's rather interesting that EPRI, in our workshop here now almost a decade ago, had a time-of-compliance of a thousand years.

The results of these assessments have led to a peak dose occurring before 10,000 years. And you all are knowledgeable of the fact that this is really caused by the igneous activity issue which puts the peak dose in a few millirem before the 10,000 years.

I should point out that in the 197 of the EPA, that they not only set the 10,000 year time period, but they also said that one has to look into the future for a period of time up to the peak risk.

In contrast to that, Part 63 only says 10,000 years.

And so I don't know how far the NRC has gone in looking at the post-10,000 years in any detail but the Department of Energy, of course, has done that

and has looked at the post-10,000 years and has found several peak doses which are of considerably greater amplitude than the igneous activity peak dose.

One of the results of the workshop on time-of-compliance was the slight changes in the performance assessment. And that was, you know, a decade ago performance assessment, the peak dose could shift around a bit in terms of time but not much in terms of amplitude. In other words, depending upon the conditions that one developed.

Next slide please. Now the international time-of-compliance views largely come out of the NEA. And I guess it's proper to say that there's no consensus. The standards and approaches differ among regulators. And, in fact, some regulators specify no time-of-compliance.

Generally, however, they have a multi-step approach with an early assessment in the 1,000 years period and a longer assessment going up to -- well, a million years or even, I think in some of the Scandinavian, up to 100 million years.

My own feeling about this is that if you look at their results, basically you'll end up with that they have a time-of-compliance which is pretty compatible with our 10,000 years but then look at it

in a sensitivity analysis at least in to that period extending into a million years.

May I have the next slide please? I asked the staff to make a slide of this because I didn't get a chance to read it. This is -- I don't know, Mike, it's 400 pages or something like that -- but this is an NEA document from a workshop in April '02 on the handling of timescales and addressing the post-closure safety of deep geological repositories.

This was brought together under the leadership of Abe Van Luik, who you all know, and Abe is the U.S. representative to the NEA's Committee on Long-Term Compliance of Repositories. And don't quote me on the exact words of the title of that.

But this is a document that I think the Committee should become familiar with and some of the references that are given in it because I think if you're going to move ahead, you have to know what's happened in the past. I'm a historian at heart.

Next slide please. Now in terms of the activities of the ACNW, over the years there were briefings regarding the EPA standards, the impact of the Energy Policy Act of '92, and then also the National Academy findings and recommendations.

Frye, the Chairman of that panel, came in

and discussed that with the Committee. And it became apparent in those days that there was this nagging question of what should be the time-of-compliance.

And so the ACNW held a working group meeting in spring of 1996. And the members, the people that appeared at that, are in a background slide if I understand correctly, Mike.

Basically there was really very good contributions from the Department of Energy, NRC, EPRI. And there were a number of academic and commercial organizations that were represented as well including a representation from the international arena.

Andy Campbell, who was the staff person that put this together -- there's Andy right there. And did -- well, I think Andy did a fantastic job. But my recollection of it, and he can back me up on that, is that we had a difficult time coming up with international representatives. But we finally did get one international representative.

Thank you for nodding your head. I think that was in a positive sense, right?

And so that will become -- the reason I'm emphasizing that is because I think that we didn't learn all we should have on an international back in

those days. And the fact of the matter, I think there was less intensity on the part of the international community than we find today on time-of-compliance.

One of the good things are the bad things, depending upon the way you want to look at it. It's that this time-of-compliance working group meeting was on both high-level waste and low-level waste.

It kind of diluted the high-level waste but the idea here was that we could bring in some of the criteria and the thinking from the low-level waste group into the high-level waste group as well.

And there were many objectives. But one is that we wanted the Committee to learn more about the regulatory context of this, the technical, scientific basis for the time-of-compliance, and alternatives to that.

Now the Committee -- if one does a search I think you find time-of-compliance in seven letters -- but the truth of the matter is -- that the Committee has produced -- but the truth of the matter is it's only the June and November '96 letters that deal with high-level waste that are really telling.

CHAIRMAN RYAN: Bill, just a quick question. Does this international document from '02 -- I'm sorry, does the international document from '02

deal with intermediate-level waste, which is a European issue more than it is a U.S. issue as well?

MR. LEE: I'm not sure. I'd certainly --

CHAIRMAN RYAN: Okay.

MR. LEE: -- have to look.

CHAIRMAN RYAN: Because sometimes that's the toughest of the three because it's kind of in between low and high and, you know, what's the right time is often discussed for those.

DR. HINZE: If you'll go back to the transcript of the working group meeting, that was a question that we did ask of the international representative in terms of their use of intermediate waste.

CHAIRMAN RYAN: Intermediate. Okay. Thanks.

DR. HINZE: And so I feel certain that since this was largely a European document, the NEA is a largely European document --

CHAIRMAN RYAN: Right.

DR. HINZE: -- that there has to be the consideration of intermediate.

CHAIRMAN RYAN: Okay. We will take a look at it when you pass it around. Thanks.

DR. HINZE: But those two letters, if I

could have the next slide please, the main ACNW messages were that no specific position was taken regarding the EPA-specified 10,000 year time-of-compliance. But that the Committee did state that certainly post-10,000 year calculations were valuable.

Now the Committee recommended a two-part approach to defining the time-of-compliance: reflecting the characteristics of the site of the repository design and the critical group.

Next slide please. There are two parts of this, as I said. One that deals with the definitive measure. That's my word. You won't find that really in the letter. But it's an attempt at a definitive measure is Part One. And Part Two is more of a sensitivity analysis.

There are three parts to this definitive measure. First of all, that we're dealing with the time that it takes for the first release of radiation to get to the critical group.

So we have -- a performance assessment of the site determines the anticipated time, that's what we call the time-of-compliance, for release and transport of radionuclides to reach the critical group.

In other words, you make your best shot at

performance assessment and get the time that it takes to reach the critical group. Now understand that's not a definitive cut off but it's a general range.

If the time-of-compliance is less than a few thousand years, for example 3,000 years, the repository is rejected or it can be redesigned because of the low integrity of the system.

If the time-of-compliance is greater than the several thousand years, then there is a comparison made through TSPA with the standard. If the performance is deficient or we reject or redesign the repository, if the performance complies, then we continue to Part Two.

In other words, at this time to reach the repository, if you meet the standard and it is beyond a few thousand years, then we go to the second part of the recommendation.

Next slide please. And that's the sensitivity analysis. And the repository performance is evaluated against the standard at the time of peak dose.

In other words, if there is more than one peak dose, you go to them all. And I'm reading that into it. It's a Bill Hinzism, if you will. But there may be more one time of peak dose. And you don't just

go to the peak dose but you look at it coming off so you make certain you're not in a local rather than a global load.

The uncertainties in the system need to be identified in this process and probabilistically quantified and their effects determined by bounding calculations.

Now the question is how do you regulate this. You know that's always the tough question. And what the Committee said was that it accepts the repository if the bounding calculations show that the repository complies within roughly an order of magnitude because the feeling that the uncertainties gave us that much leeway, an order of magnitude of the standard. Otherwise, you redesign or reject the repository.

Now, ladies and gentlemen, bear with me. Next slide please.

CHAIRMAN RYAN: Oh, my goodness.

DR. HINZE: Yes, well, this is why I'm asking you to bear with me.

In the November letter, there was included a flowchart which tried to make this a little simpler. And this you can't read unless you're really in phase with the fuzziness here. But I just wanted to show

you that type of thing and you can see that in the letter.

Next slide please. What we see is -- and I'm not going to bore you with all of the details here but this was an attempt to try to put this on some type of a quantitative basis. And you reject the repository, you redesign.

If it's not less than 3,000 years or so, you do a TSPA. And if it meets the standard, then you continue on to the second phase.

Next slide please. And the next slide is -- we have the PA work here along with analogues and experiments to study the time to reach peak dose, TSPA. And again, comparison with the EPA standard comparison. And if the repository complies, then you've got a repository.

Next slide please. I'm glad there are no questions. The --

PARTICIPANT: So far.

DR. HINZE: At the end of '96, the Committee received a letter from the EDO regarding the June and November letter. And it's an interesting letter. And I strongly recommend that you read it.

First of all, the staff supported a tiered approach. Now I might say that there is no tiered

approach in 63. The ACNW's recommendation fails to consider associated policy issues.

Well, that's just exactly what we're trying to avoid. And that's what the court just told us here, if you will. And the attempt of the suggestion by the Committee was to avoid that.

Staff is concerned that there's too much emphasis on quantification of exact time. I have some personal problems with this because PA is what they're doing all the time and coming up with numbers. And I don't think the Committee has thought about this as a very specific time.

Finally, the staff believes that the 10,000 years is adequate in the context of a tiered approach, which is the recommendation that you have made. The time-of-compliance also involves programmatic issues such as contributions from individual variants, the old defense in depth.

Now let me make some personal observations about this and you can have fun with me. Most of the problematic aspects of the time-of-compliance are derived from these uncertainties in the post-10,000-year repository period. And if you look at those, most of those really are speaking in terms of the geological barrier.

And let's look at some sub-bullets here. One of them is that we hardly have unanimity of view point by very good scientists on this point that the uncertainties are too large to deal with or that you can deal with them.

For example, the Science Advisory Board of the EPA -- and I only know one geoscientist that was on that and he is very good -- they agreed that the uncertainties beyond 10,000 years were too great to bound.

And then we have the National Academy Panel which says the opposite. It's interesting that -- and I'll make an observation here, a Bill Hinzism, that the two geoscientists on the National Academy of Science Panel are -- one's a hydrologist and one's a geohydrologist. There's no one involved really in tectonics or seismicity or igneous processes.

And as I looked at this, I wondered in my own mind how these panels would stack up to the NRC regulation on expert judgment. What's the number of it, Mike? You wrote it.

MR. LEE: I think it's 1536.

DR. HINZE: Well, right. We have very specific requirements for expert judgment.

MR. LEE: Yes.

DR. HINZE: And this is an expert judgment, ladies and gentlemen. It's an expert judgment because this is a subjective argument. And it is open to differences of opinion.

Now there are variations in the geological processes and events. And we know that. But these can be minimized by collecting the proper data, doing the analysis, and, in fact, a great deal has been done, as we know, in the last decade.

And also the use of geological analogues. I know Rod Ewing doesn't believe in -- even though he is Mr. Geological Analogues. He's concerned about using them for time-of-compliance. And he so stated at your working group meeting in '96.

But nonetheless, geological analogues can be used in this, especially with the transport. And I'm thinking of Sierra Blanca, for example.

There are large uncertainties not only in these geological barriers but certainly in the climatic change and the whole area of biosphere and critical group. And I should also include in here, and we'll get to that in a moment, the near-field environment engineered barriers.

Another statement that we -- I guess we don't have to make is that absolute proof of

repository behavior is unnecessary.

If I could have the next slide please? Some more observations. There is an increasing dependance on engineered barriers and a diminishing role of geological barriers.

I guess -- I think it was Rod Ewing a couple years ago, again, that wrote the article in Science that says this is no longer a geological repository.

He may be stretching it a bit, and I hope he is, but the point is that with the recognition of the fast pathways in the vadose zone, that what we have ended up with is an enhancement of the engineered barriers, that is a more robust cannister and drip shields.

Now the question then is what is the impact of this change on the concerns about the uncertainty, which are the principle stumbling block in the TOC. It's probably significant, in my view, because of the limited knowledge of uncertainty in the long-term performance of the engineered barrier.

And the canisters and drip shields, you know, I attended the research review on that last year I guess that was -- that was earlier this year -- I don't have a warm, fuzzy feeling that we have a long-

term feel for the uncertainties in there. And that certainly also goes to the near-field geochemistry. And you can go on and on with these items that deal with the engineered barrier.

Another observation, and this is -- once you become an emeritus professor, you're allowed a certain amount of cynicism, the differences regarding what a policy decision is. The NRC believes that the post-10,000 is a policy decision. But then the National Academy says it's a technical decision.

The time-of-compliance of 10,000 years started off really in this comparative realm of regulatory space as a safety indicator.

But with increasing use of performance assessment, in my view we've forced ourselves into a more rigid cutoff of this kind of compliance -- 10,000 years now means 10,000 years, .000. And I'm stretching the point.

But -- and the net result is that PA may give us a false sense of accuracy, a false sense of security.

Next slide.

CHAIRMAN RYAN: But just a counterpoint here, Bill. Doesn't the fact that you're doing a performance assessment in a probabilistic way -- sorry

-- doesn't the fact that you're doing this performance assessment at a point in time in a probabilistic way give you a range of outcomes that helps you understand uncertainty?

DR. HINZE: It certainly should. But what I'm concerned about here, Mike, is the fact that we give this 10,000 years as a very specific cutoff in time.

CHAIRMAN RYAN: Yes, if your point is you could do that probabilistic assessment of 10,000, or 11,000, or --

DR. HINZE: Exactly.

CHAIRMAN RYAN: -- 9,000 --

DR. HINZE: Exactly.

CHAIRMAN RYAN: -- that's fine. But I just wanted everybody to recognize that a PA that's done as a deterministic is one question but when you really do a probabilistic many hundreds of thousands of runs, you do get a sense of uncertainty at least at that point in time. And maybe the question you're raising is if you do it on the y-axis --

DR. HINZE: Yes.

CHAIRMAN RYAN: -- why not do it on the x-axis?

DR. HINZE: Yes, right.

CHAIRMAN RYAN: Is that what you're really saying?

DR. HINZE: Yes.

CHAIRMAN RYAN: Okay.

DR. HINZE: Well, not only that but also the fact that we give this as a very specific time despite the fact that we do PA in a probabilistic way. CHAIRMAN RYAN: Well, and the key there is, of course, you're doing the variation on things that effect the y-axis.

DR. HINZE: Yes.

CHAIRMAN RYAN: Your point is maybe the x-axis would be interesting, too.

DR. HINZE: Exactly.

CHAIRMAN RYAN: Okay. Thanks.

DR. HINZE: Next slide please. The ACNW may wish to obtain additional information, vis a vis a working group, and on international approaches to time-of-compliance. I think since '96, there has been an increase in interest in this and more thought.

And we also could look at long-term technical uncertainties with regard to engineered barriers and policy considerations with respect to human physical evolution over a million years, the changes in lifestyle, climatic change and so forth.

I guess I would finish up here by saying that the past ACNW's advice on high-level waste time-of-compliance, I think it is viable. It's technical. It's about as technical as we've seen.

It uses performance assessment in a probabilistic manner. But it is complex. And not everyone is going to understand it or believe that it works. But I believe that this is technically justifiable.

Now the question is what might be the future role of the ACNW on this topic. And that's for you to discuss. That's it.

CHAIRMAN RYAN: Bill, thanks very much. That was a very informative presentation on the history of time-of-compliance particularly from your tenure on the ACNW. So we appreciate your bringing us that body of experience in about 45 minutes. That was great to hear all that.

As you talk, I guess the one question that strikes me is what you finished up on is that the idea for a working group. Maybe that's an approach we ought to think more carefully about.

I guess it would be helpful if we could review, Mike, and I don't know how many copies of that International Workshop you have -- but --

MR. LEE: You will have it on your --

CHAIRMAN RYAN: Tell me it will be on a CD.

MR. LEE: It is.

CHAIRMAN RYAN: Oh, good.

MR. LEE: You have it in your CD. It's one of the folders in --

CHAIRMAN RYAN: Oh, okay.

MR. LEE: -- in Tab 3.

CHAIRMAN RYAN: In the current one. Okay. I didn't look at that folder.

MR. LEE: But I can send you a message to let you know which one exactly.

CHAIRMAN RYAN: Okay. Great. And maybe that's the thought is to digest them. I'm curious what the international view is.

I have seen many of the NEA publications come across on repository time horizons and time-of-compliance and lots of other related time-dependent issues. So there's certainly something there and of recent vintage --

DR. HINZE: Well, I --

CHAIRMAN RYAN: -- that might help us.

DR. HINZE: Excuse me.

CHAIRMAN RYAN: Go right ahead.

DR. HINZE: Well, I think we're very fortunate, too, in that Abe Van Luik is the chair -- is the U.S. representative.

MR. LEE: Yes, I think Abe is the U.S. representative.

DR. HINZE: Yes, the U.S. representative.

MR. LEE: And I'm not sure who the chair is.

DR. HINZE: Okay. But he was the honcho on that report.

MR. LEE: He's local.

DR. HINZE: Yes, right.

CHAIRMAN RYAN: And the other is the idea of this -- there's actually two. I mean what, you know, how does the time influence the barriers and how they interact and then this idea that we've kind of kicked on here at the end of what's the x-axis, in fact, on uncertainty, probabilistic analysis versus just the y-axis.

DR. HINZE: You know, I think --

CHAIRMAN RYAN: It would be interesting to explore that, I think.

DR. HINZE: Yes, you know I really think that things have changed since the thinking developed for 197 and 63. So I think there's a place here to

look at that again. So let me leave it at that.

CHAIRMAN RYAN: Okay. Any other questions or comments?

MEMBER WEINER: I have a couple.

I take it from your comments, Bill, that 10,000 years is read by -- generally as 10,000 years and not 20,000 years or 30,000 years. And it seems to me we don't have that many significant figures that we can do that. I mean isn't 10,000 years basically the same as 20,000?

CHAIRMAN RYAN: From what point of view?

MEMBER WEINER: From the point of view that if you are extending something to 10,000 years, you really -- 10,0001 years doesn't mean anything, 10,100 years doesn't mean anything. So it's no different.

DR. HINZE: Well, I was at a meeting one time on markers and barriers for the high-level waste repository and there was a large international contingent there. And we were discussing the length of time that these markers would have to be preserved. And 10,000 years came up.

And one the international people stood up and said just where did this 10,000 years come from? And anecdotally, I think what we hear is that -- and

that came out at that meeting -- and what we hear is that this 10,000 years is kind of the cycling period for glacial activity.

And that's -- I've asked that question specifically of people on the SAB. And they say no, it wasn't the controlling factor at all. But it is mentioned by the EPA.

And so 10,000 years is not 20,000 years.

I guess another point that bears on this is that I think we have this idea, rather simple, that there was going to be one peak dose. And I think that's what we see in this document. We see a peak dose.

And I don't have a slide of this but this is one of the realizations of the DOE. Notice here how these --

CHAIRMAN RYAN: What's that from, Bill? Could you just tell us what document it is in?

DR. HINZE: My friend Mike got this for me.

MR. LEE: It's the final EIS for Yucca Mountain.

CHAIRMAN RYAN: Okay.

MR. LEE: And I think Bill -- there's actually a couple pages. And the one I Xeroxed for

Bill, I think he's making reference to page 5-26, which is --

DR. HINZE: Yes, 5-30.

CHAIRMAN RYAN: Okay. I just wanted to make sure --

MR. LEE: Yes, 5-30, I'm sorry.

CHAIRMAN RYAN: -- we understood what he was talking about.

DR. HINZE: I think we have -- if we're going to have repository performance that's going to reach multiple peaks, we have to make pretty certain if we consider peak dose that we're not in a local -- have a local peak but that we have a global peak, if you will. That I think bears heavily upon this looking at time-of-compliance in the future.

CHAIRMAN RYAN: Yes.

Ruth, your question is an interesting one because it made me think about is 10,000 different than 20,000? When? Why? Under what basis? If it's based on what's left and what's decaying, you know, you always think about that as an exponential. It's always going down so 20 is better than 10.

But if you think about a more complex system where confinement and containment fractions vary over time and get bigger with time or get bigger

then smaller and maybe bigger again, I mean that's the kind of thing that could be interesting to think about.

So I think the answer to your question is under what condition is it interesting? So maybe that's some of the things, Bill, you're talking about as having a newer view or more recent information on.

DR. HINZE: Right.

CHAIRMAN RYAN: That makes sense Mike? I mean you've been reading a lot of this stuff?

(No response.)

CHAIRMAN RYAN: Other questions? Jim?

DR. CLARKE: Bill, I was curious, your workshop you mentioned in '96, you said you invited people to talk from both the low-level and the high-level perspective, you know, to see if there would be some synergy there? Would you do that again?

DR. HINZE: No, I wouldn't.

DR. CLARKE: Yes.

DR. HINZE: I don't think there's much to be learned for the low-level waste. And looking at the transcript again, I don't think that it really gave us much information that was useful in the high-level waste.

I think the cart and the horse are turned

around there. I think the high-level waste is more useful than the low-level waste.

DR. CLARKE: I guess you could argue it's a common theme to, you know any waste --

DR. HINZE: Yes, yes.

DR. CLARKE: -- classification.

DR. HINZE: Right, right. And that's why Andy and I, because we kind of set this up, felt that we should look at both. And the fact of the matter is, I think it was in February of '97, we did write a letter suggesting a similar approach for low-level waste, which I still think is extremely viable.

And perhaps there are certain advantages to what the Committee recommended over some of the recommendations that we have in front of us today. Was that subtle enough?

DR. CLARKE: Yes, thank you.

DR. HINZE: Okay.

CHAIRMAN RYAN: And, of course, in the international arena more than in U.S., there's the intermediate waste class.

And to me that's just as interesting from the standpoint that, you know, you think about things like ruthenium and tech-99 and other radionuclides that are in the same mode as some of the longer-lived

species in the high-level game where they're transcending boundaries of barriers that are engineered.

So I think the trick is not so much whether it's high, intermediate, or low but are the confinement schemes such that they're challenged by the life of the radioactive material is what I'm getting it.

DR. HINZE: Right.

CHAIRMAN RYAN: So maybe that's the theme. What's the containment and confinement strategy and certainty versus how long is the radioactive material going to be around.

DR. HINZE: I guess maybe, Mike, that was one of the reasons that I wanted to show these diagrams --

MR. LEE: Sure.

DR. HINZE: -- from the ore body versus the SNF.

MR. LEE: Right.

DR. HINZE: I think those diagrams are very useful in looking at this in the context.

CHAIRMAN RYAN: What ore body was that? Was that rich ore or a weak ore?

DR. HINZE: Well, it would have to be a

pretty rich ore.

CHAIRMAN RYAN: Okay. That's what I thought.

DR. HINZE: Yes.

CHAIRMAN RYAN: Okay.

Any other questions? Allen, anything?

VICE CHAIRMAN CROFF: Yes. At the risk of maybe going where I shouldn't but if we were to think about let's say a working group on one of these topics we've talked about and we learned a lot of things and thought we had some ideas, who would we be advising?

I mean recognizing we sort of know the legal situation and any nixed action is the EPA's. Would we write a letter to the Commissioners suggesting that this is something they might want to express to the EPA someday? Or --

CHAIRMAN RYAN: Well, I don't know that we -- first of all, I don't know that we'd have a working group. Second of all, I don't know if the working group would end up with a letter.

But to answer your question, to me, you know, our advice is on technical matters. And our advice is directed to the Commission. So I don't know, you know, whether it would be information that's new and emerging from some of these other documents

and working groups that might be helpful to their deliberations or not. So the answer is I don't know.

But I think the focus here that we would have to any working group, as we have all the ones we have had, is what are the technical issues? And, you know, can we shed meaningful light on what's known and what's not known? And what needs attention. And what seems to be okay. And then what the details are on the technical basis.

I don't think it's our purview to recommend a policy decision. But certainly if there is technical information that can better inform the Commission, that's what we'd be after.

VICE CHAIRMAN CROFF: Okay. I think.

(Laughter.)

DR. HINZE: Could I interject something there?

CHAIRMAN RYAN: Please.

DR. HINZE: One of the bullets that Mike pulled out of the ACNW's letter, which I extracted from the slides, was a bullet in which the ACNW has made the recommendation that the time-of-compliance not be included in the EPA standards but be included only in the NRC regulations.

In other words, the EPA sets the dose and

the risk and the NRC determines how to comply with that. And so maybe there is a place here for some advice.

CHAIRMAN RYAN: Other questions or comments?

MR. FLACK: Yes, if I can.

CHAIRMAN RYAN: Please.

MR. FLACK: We talked about, you know, if we do a calculation for 10,000 years that there may be conservatisms in that calculation that might come back to haunt you.

CHAIRMAN RYAN: John, just for the record, would you let the --

MR. FLACK: Oh, I'm sorry, John Flack, ACRS -- ACNW at this point, I'm sorry.

And the question might be entertained within this working group, as we mentioned once before, that you may want to look at what conservatisms might be in the analysis that you do for the first 10,000 years that might come back to haunt you if you go further out.

In other words, going further out requires a realistic assessment. There's no question about it. It's hard, you know, to do a conservative analysis because in the end, these things will tend to grow on

you as you go further and further in time.

So maybe in that context, a working group would be useful in identifying where these things may have to be changed in the PA if you were to go beyond 10,000 years.

CHAIRMAN RYAN: Well, and that's -- I mean if you had to pick a focal point, I think what we're really saying when we say that is what we talked through, Bill and I, just a minute ago, about we tend to focus on what happens on the y-axis --

MR. FLACK: Yes.

CHAIRMAN RYAN: -- at a time. What happens if we focus on the x-axis over time?

So that -- I mean that's really the succinct way I think of agreeing with you that that would be an interesting thematic approach to examine that technical question.

Ruth?

MEMBER WEINER: I was wondering, as you were talking and I reread some of the ACNW letters, in your opinion, what does -- does meeting the dose limit mean that the average meets it? The 95th percentile? The 99th percentile? What do you think that should mean?

DR. HINZE: Well, as long as you throw me

the real easy questions, that's no problem.

Well, you know, what you're really getting to is what is reasonable assurance.

MEMBER WEINER: Exactly.

DR. HINZE: And, you know, I was taught in grade school that reasonable assurance meant that you cut off the tails and you only looked at that central portion. Perhaps the five to the 95. And statisticians can give us support for that I suspect.

CHAIRMAN RYAN: Other questions or comments?

DR. HINZE: Well, I guess --

CHAIRMAN RYAN: Yes, please.

DR. HINZE: -- one thing -- in the discussion with John, one of the things -- John, if you have a chance to look at some of the transcript of the working group in '96 because there's this discussion of the fact that it doesn't take much of the performance assessment to move that peak dose around. And --

CHAIRMAN RYAN: But you said -- the interesting point that you made was it changes the location but not the amplitude.

DR. HINZE: The amplitude, right, right. And that's something that comes through strongly in

that transcript. And EPRI, I know, was one of those that -- John Kessler was one of those that was discussing that. And there was at least another person or two.

CHAIRMAN RYAN: So this is information now that in performance assessments codes that were in the eight-year-old time range now?

DR. HINZE: Yes, right.

CHAIRMAN RYAN: It would be interesting to see --

DR. HINZE: Well, it's --

CHAIRMAN RYAN: -- if the more modern versions --

DR. HINZE: -- ten years old now.

CHAIRMAN RYAN: -- or ten years old now.

DR. HINZE: Yes.

CHAIRMAN RYAN: It would be interesting to see what the current view of that would be.

DR. HINZE: Yes.

CHAIRMAN RYAN: If that's been updated and approved.

DR. HINZE: That's right. That's why I say we're almost looking at a new animal here.

CHAIRMAN RYAN: Well, the x-axis question is kind of intriguing to me.

DR. HINZE: Yes.

CHAIRMAN RYAN: Any other questions or comments?

(No response.)

CHAIRMAN RYAN: Well, Bill, you've given us great food for thought. As always, we appreciate your counsel and your views and the great information you've provided. We've got a lot to study as we take up the question of where do we go next.

Yes?

MR. LARSON: And remember one of the reasons -- well, the reason why you did this was that we put together a list of all of the letters the Committee had written --

CHAIRMAN RYAN: Right.

MR. LARSON: -- related to the topic and divided them up into different types of subjects. And then we said okay, let's pick one and we'll look at that one as to what the Committee has done over the past. And decide whether that looks like it's a worthwhile template for us to use for member and staff to look at other particular areas.

So I guess my question is was this a worthwhile process that we just did? And if it is, then we ought to take a look at that divvying up of

letters that we did and decide, you know, which ones do you want to do next and who do you want to do them with.

CHAIRMAN RYAN: I'd be happy to have everybody comment on it. But it sure has been informative and pretty efficient from my standpoint of having all the materials and then having a well-informed presentation like the one Bill gave. Yes, resoundingly so. Anybody else want to comment?

MEMBER WEINER: That's a very good way to look at the past.

MR. LARSON: So I guess then we've got to take a look at that list of letters and decide if you like this type of thing, recognizing that other topics may not be as succinct.

CHAIRMAN RYAN: Maybe the thing to do is to look at the letters and the groupings and see how they line up with our action plan.

MR. LARSON: Okay.

CHAIRMAN RYAN: And use that to -- use that as the guide to order them. I mean, you know, I wouldn't want you working on something that wasn't coming up on the calendar in a, you know, in a timely way so you're working on things that are timely and coming up and not rushed and not too far ahead and so

forth.

DR. HINZE: A good example of that is human intrusion. I mean there are a number of letters on human intrusion. And yet that's not a topic of immediate interest.

CHAIRMAN RYAN: Right. Okay?

(No response.)

CHAIRMAN RYAN: I think that brings us to the end of -- Bill, your hour or so.

Our next item on the agenda is the ACNW 2005 operating plan. Who has the operating plan?

MR. FLACK: That brings us back to where we were before.

CHAIRMAN RYAN: Okay.

MR. FLACK: And I guess we can -- at this point, do you want to go off the record?

CHAIRMAN RYAN: Do we need to have the -- we can go off the record at this point? Okay, yes, I think we're through with the formal part of the record. So thank you very much.

(Whereupon, the above-entitled meeting was concluded at 5:01 p.m.)

CERTIFICATE

This is to certify that the attached proceedings before the United States Nuclear Regulatory Commission in the matter of:

Name of Proceeding: Advisory Committee on Nuclear Waste 156th Meeting

Docket Number: n/a

Location: Rockville, MD

were held as herein appears, and that this is the original transcript thereof for the file of the United States Nuclear Regulatory Commission taken by me and, thereafter reduced to typewriting by me or under the direction of the court reporting company, and that the transcript is a true and accurate record of the foregoing proceedings.

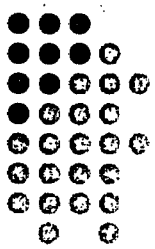
Rebecca Davis
Official Reporter
Neal R. Gross & Co., Inc.

TIME PERIOD OF COMPLIANCE FOR GEOLOGIC REPOSITORY PERFORMANCE ASESSMENTS

William Hinze
Purdue University

Michael Lee
ACNW Staff

Presentation to the
Advisory Committee on Nuclear Waste
December 13, 2004



Outline

- Basis for Time of Compliance (TOC)
- EnPA92, Section 801 Direction
- NAS 95 Findings and Recommendations
- Yucca Mountain-Specific TOC and Court Remand
- National/International Perspective
- Previous ACNW Views and Recommendations
- Personal Observations (Hinze)

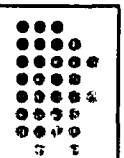
2

Basis for Time of Compliance (TOC)

- What is Time Period of Regulatory Compliance?
  - Minimum Time - Complies with Standard – Critical Group (REMI)
  - "The minimum time period over which the repository system must meet the dose limits or risk to the reference biosphere and critical group as established by a repository standard"
- Comparative, Generic, and Repository-Specific TOC
- Criteria Employed

3

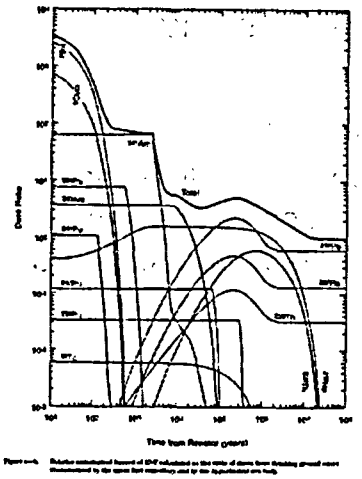
TOC Criteria: Generic Repository

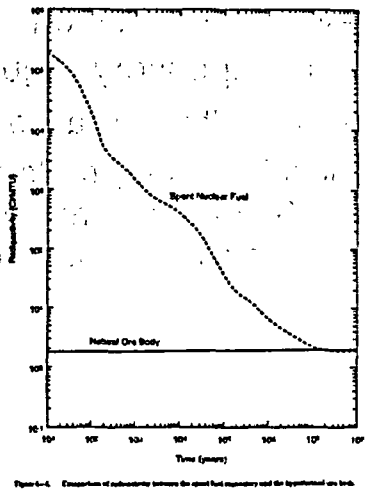


- Sufficient period of time to insure safety (dose, risk) of humans and environment from release of radiation by loss of integrity of barriers
- Adequate time period to incorporate significant processes and events that impose greatest risk
- Restricted to time period during which uncertainties can be prescribed with reasonable assurance
- Sufficient time that source term is drastically decreased and is roughly equivalent to the hazard of a hypothetical equivalent ore body

4

Comparison of Radionuclide Hazard from SNF and Ore Body (NUREG 1538)





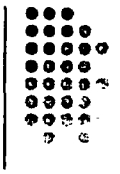
5

TOC Criteria: Specific Repository

- Generic Repository Criteria (Slide 4)
- Performance assessment of specific repository and critical group
  - Source inventory and waste form
  - Nature, level of activity, and rate of change of geologic, tectonic, igneous, and climatic processes and events
  - Waste canisters and drip shield
  - Underground openings
  - Location, nature, and evolution of biosphere, culture, and humans in reference biosphere and critical group
- Regulatory consistency; national and international; LLW, WIPP, etc.
- Simple and understandable

6

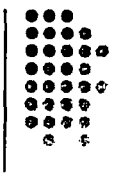
Energy Policy Act of 1992



- Develop new radiation standards and geologic repository regulations
  - Specific to the Yucca Mountain Site
  - National Academy of Sciences (NAS) to advise the U.S. Environmental Protection Agency on the appropriate technical basis for radiation standards

7

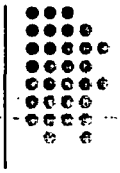
NAS 1995 Findings and Recommendations



- With respect to existing 10,000-year TOC
  - "no scientific basis for limiting the time period of the individual risk standard to 10,000 years or any other value"
  - "...compliance assessment is feasible for most physical and geologic aspects of repository performance on the time scale on the order of 10^6 years at Yucca Mountain..."
  - "...that compliance assessment be conducted for the time when the greatest risk occurs, within the limits imposed by the long-term stability of the geologic environment..."

8

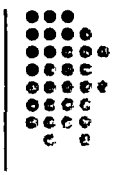
Existing Yucca Mountain Standards



- EPA radiation regulations: 40 CFR Part 197
  - 10,000-year TOC
- NRC standards: 10 CFR Part 63
- TOC Now Remanded

9

U.S. Performance Assessments



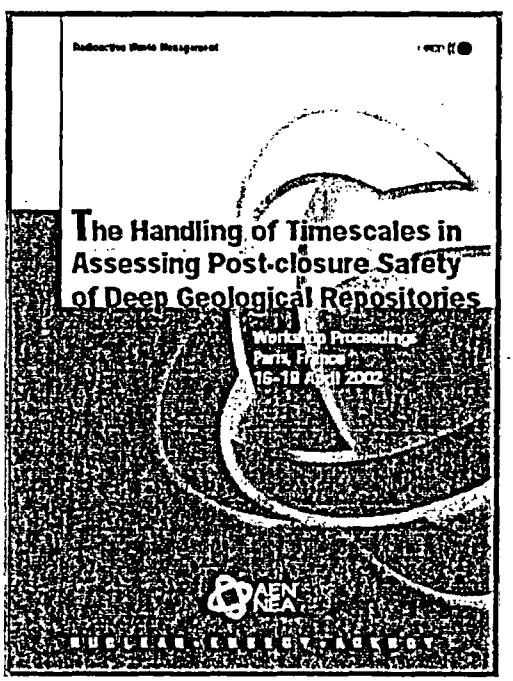
- DOE, NRC, and others conducting site-specific performance assessments for decades
  - Consider 10,000-year TOC
- Results
  - Peak dose occurs before 10,000 years
  - Doses estimated in millirem
  - Post-10,000-year peak dose

10

International TOC Views: NEA

- No consensus
  - Standards/approaches differ among regulators
- Generally, a multi-step approach
  - Early assessment: ~10^3 years
  - Longer assessment: 10^3 to 10^6 years, or longer
- Some regulators specify no TOC

11



12

Past ACNW TOC-Related Activities

- Briefings
  - Implementation of EPA Standards
  - Impacts of EnPA
  - NAS Findings and Recommendations
- Sponsored TOC Working Group Meeting
  - March 27, 1996
  - HLW & LLW; Regulatory context and technical basis
- Actions
  - Seven TOC-related Letter Reports produced between 1991-97

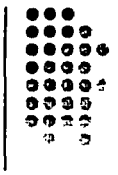
13

Main ACNW Messages

- No specific Committee position on EPA-specified 10,000-year TOC
  - Post 10,000-year calculations valuable
- Committee recommended two-part approach to defining the TOC
  - Reflect characteristics of repository site and design

14

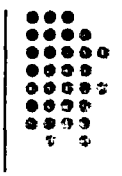
Past ACNW TOC Recommendations:



- Part 1 (Definitive Measure)
  - PA of site determines the anticipated time (TOC) for release and transport of radionuclides to reach the critical group
  - If TOC is less than ~$3x10^3$ years the repository is rejected or redesigned because of low-integrity system
  - If TOC is greater than several thousand years, compare TSPA performance with standard. If performance is deficient reject or redesign repository, if performance complies continue to Part 2

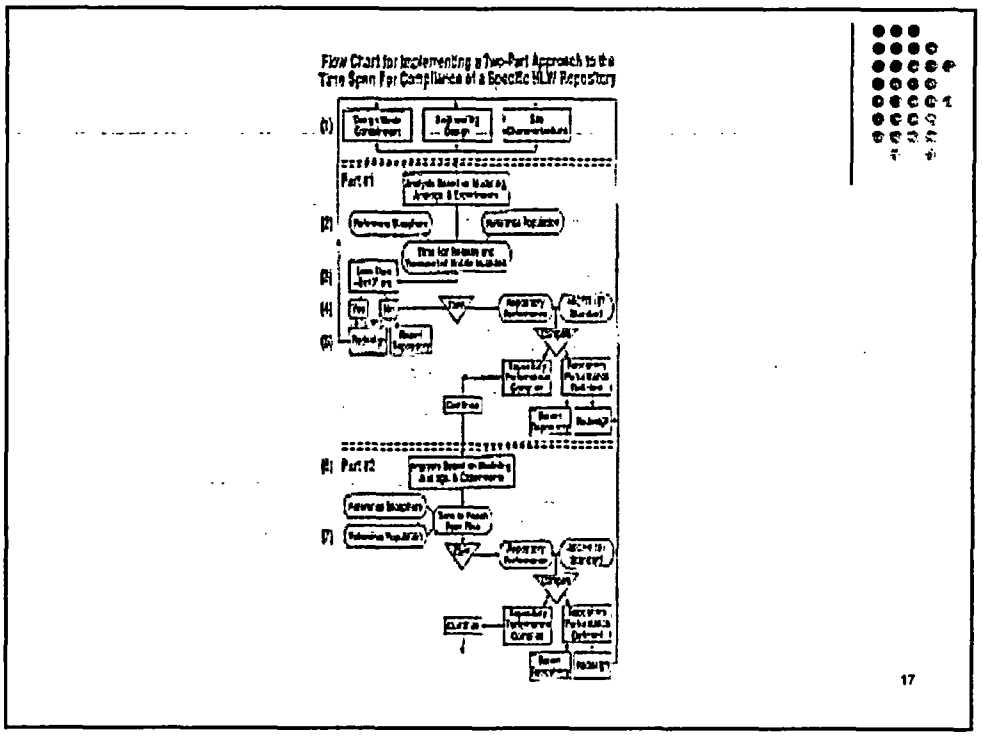
15

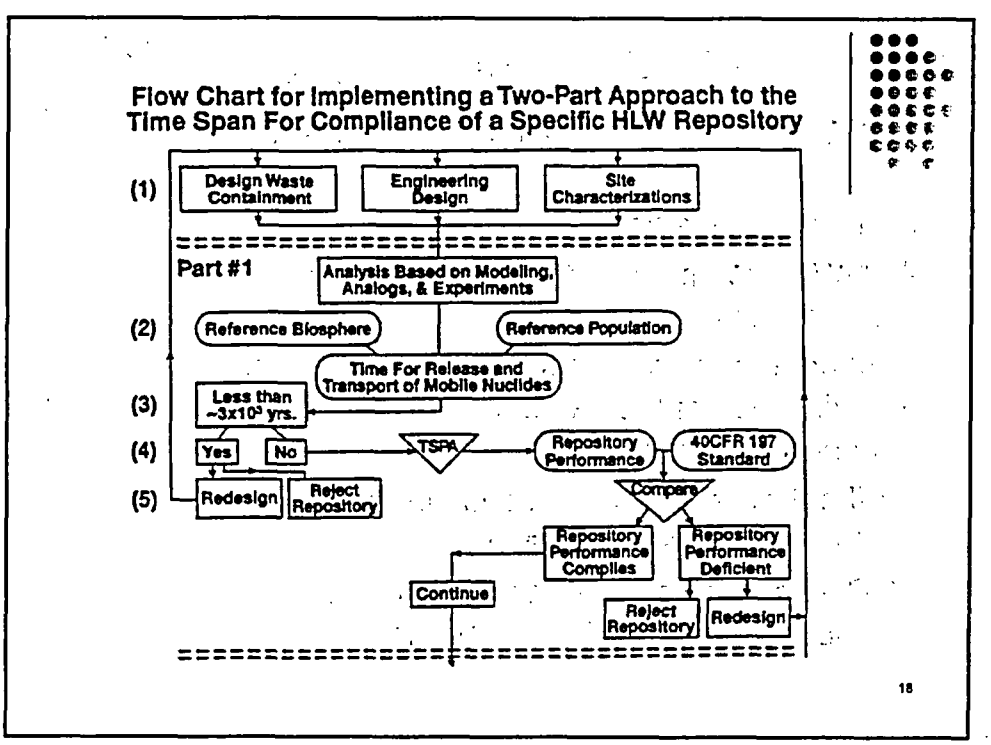
Past ACNW TOC Recommendations (cont.)

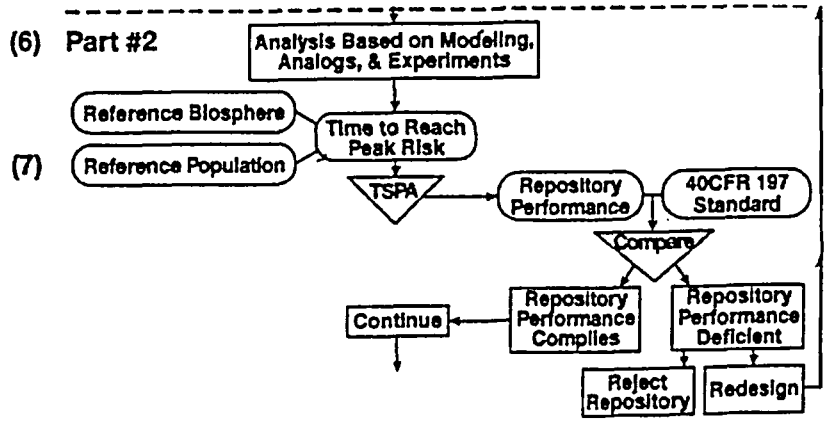


- Part 1 (Definitive Measure)
- Part 2 (Sensitivity Analysis)
  - Repository performance is evaluated against standard at time of peak dose
  - Uncertainties in the system should be identified and quantified probabilistically, and their effects determined by bounding calculations
  - Accept repository if bounding calculations show the repository complies within roughly an order of magnitude of the standard, otherwise redesign or reject repository

16


Flow Chart for Implementing a Two-Part Approach to the Time Span For Compliance of a Specific HLW Repository
17


Flow Chart for Implementing a Two-Part Approach to the Time Span For Compliance of a Specific HLW Repository
(1)
Design Waste Containment
Engineering Design
Site Characterizations
Part #1
Analysis Based on Modeling, Analogs, & Experiments
(2)
Reference Biosphere
Reference Population
Time For Release and Transport of Mobile Nuclides
(3)
Less than ~3x10³ yrs.
(4)
Yes
No
TSPA
Repository Performance
40CFR 197 Standard
(5)
Redesign
Reject Repository
Compare
Repository Performance Complies
Repository Performance Deficient
Continue
Reject Repository
Redesign
18



19

Commission's Response to ACNW's TOC Letter Reports

- Staff supports a tiered approach
- ACNW's recommendation fails to consider associated policy issues
- Staff concerned that there is too much emphasis on quantification of the exact time of release and transport to critical group
- Staff believes 10,000 years is adequate in the context of a tiered approach
- TOC also involves programmatic issues such as contributions from individual barriers

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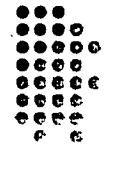
Personal Observations (Hinze)



- Problematic aspects of TOC largely are derived from estimates of uncertainties in post-10,000 year repository performance analysis of geologic barriers
  - Subjectivity has led to different conclusions
  - Variations in geologic processes and events can be minimized
  - Large uncertainties in biosphere, critical group, climatic change
  - Absolute proof of repository behavior is unnecessary

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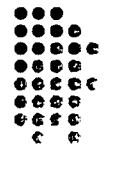
Personal Observations (cont.)



- Increasing dependence on engineered barriers and diminishing role of geologic barriers.
  - What is the impact of this change on concerns about uncertainty?
  - Probably significant because of limited knowledge of uncertainty in the long-term performance of engineered barriers including both canisters and drip shields, near-field geochemistry, etc.
- Differences regarding what is a policy decision, e.g., NRC believes post 10,000 years is a policy decision, but NAS believes it is a technical decision.
- TOC of 10,000 years started off as a safety indicator, but with increasing use of PA focuses has become a rigid cut-off and PA may give a false sense of accuracy.

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Personal Observations (cont.)

- The ACNW may wish to obtain additional information (working group)
  - On international approaches to TOC
  - Long-term technical uncertainties and policy considerations (re: canister and drip shield integrity, reference biosphere including human physical evolution and changes in lifestyle, climatic change, tectonic changes)
- Past ACNW's advice on HLW TOC is viable, but is complex

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Back-up Slides