UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

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BRIEFING ON IMPLEMENTATION OF THE U.S. ENVIRONMENTAL PROTECTION AGENCY'S HIGH-LEVEL WASTE DISPOSAL STANDARDS

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PUBLIC MEETING

Nuclear Regulatory Commission
One White Flint North
Rockville, Maryland

Tuesday, November 21, 1989

The Commission met in open session, pursuant to notice, at 9:00 a.m., Kenneth M. Carr, Chairman, presiding.

COMMISSIONERS PRESENT:

KENNETH M. CARR, Chairman of the Commission
THOMAS M. ROBERTS, Commissioner
KENNETH C. ROGERS, Commissioner
JAMES R. CURTISS, Commissioner

STAFF SEATED AT THE COMMISSION TABLE:

SAMUEL J. CHILK, Secretary

WILLIAM C. PARLER, General Counsel

JAMES TAYLOR, Acting Executive Director for Operations

ROBERT BERNERO, NMSS

SETH COPLAN, NMSS

ROBERT BROWNING, NMSS

DANIEL FEHRINGER, NMSS

DOCTOR HERBERT KOUTS, Defense Nuclear Facility Safety Board

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

9:05 a.m.

CHAIRMAN CARR: Good morning, ladies and gentlemen.

Nuclear Waste Policy Act of 1982 directed the Environmental Protection Agency to promulgate generally applicable standards for protection of the general environment from off-site releases from radioactive material in high-level waste repositories.

EPA promulgated these standards in 1985, but portions of the standards were vacated in 1987 by a U.S. Court of Appeals. In August 1989, the Commission requested the staff to advise the Commission of the status of EPA's high-level waste disposal standards development and the NRC staffs reevaluation of its views on implementation of probablistic standards.

The Commission also asked the staff to report on the status of the reevaluation the use of such quantitative standards by development of procedures and rules needed for implementing the standards. The purpose of today's meeting is to hear from the staff on these matters and to discuss staff's request to pursue a continuing evaluation of the EPA standards through interactions with the EPA staff and through NRC rulemaking.

At the suggestion of Commissioners Curtiss and Roberts, we will also hear from Doctor Herbert Kouts. Doctor Kouts has previously served as Director of Research at the Nuclear Regulatory Commission, Chairman of the Department of Nuclear Energy at Brookhaven National Laboratory and is currently serving as a member of the Department of Energy's Defense Nuclear Facility Safety Board. Doctor Kouts has a wealth of experience in the application of probablistic techniques and the Commission appreciates his willingness to share his views on this important subject.

Copies of the presentation slides should be available at the entrance to the meeting room.

Do any of my fellow Commissioners have any opening comments?

If not, Mr. Taylor, you may proceed.

MR. TAYLOR: Good morning, sir. With me at the table from staff are, to my immediate left, Bob Bernero and Bob Browning. To my right, Seth Coplan and Dan Fehringer, all from NMSS. Mr. Bernero will be the principal briefer this morning.

I would like to make two points before proceeding with the briefing. My first point is that this is the first staff briefing since your recent

discussions concerning the quality of staff briefings and we have tried to incorporate the comments and instructions in what we will do today.

My second point regards the content of the briefing itself. As you noted, we're concerned here with an important issue, interfacing with the Environmental Protection Agency. In this case, as you noted, the issue is whether an EPA environmental standard for high-level waste disposal which utilizes probablistic values is in a form which can be used effectively in the NRC licensing process.

As you will note from the paper provided, the answer to that is not a simple yes or no. We have provided a lengthy discussion on the subject in the paper provided you and you outlined our recommendation of plans to pursue a long-term, ongoing evaluation of the standards, both by close contact with EPA to resolve implementation issues for these standards, and to further resolve these issues in NRC's own implementing rulemakings.

For this briefing, Mr. Bernero will not completely review the elements of the Commission paper, but will emphasize the bases and elements of the EPA standards, NRC concerns with their application and a reiteration of the staff recommendation.

Mr. Bernero?

MR. BERNERO: Thank you, Mr. Taylor.

I'd like to add note of the presence of one other person. Daniel Egan, the principal author of the EPA standard, is in the audience because of the obvious interest in the matter.

(Slide) May I have slide two, please?

In the outline we have in your slide package, I just want to note one thing. That is that I think it's useful if at the outset we add something that isn't in the paper we submitted to you on the underlying basis of the high-level waste standards. I think it will be useful in the reflections on the content of the paper.

(Slide) May I have slide three?

An obvious thing when you look at it for awhile is that high-level waste repositories are not needed to protect present generations. For 100 years or so we could easily protect the people with storage of high-level waste. The high-level waste are there for future generations, over the very, very long time period and the underlying basis of standards for them is that we project that future generations will have the same bodily habits, eating, drinking and vulnerability to cancer from radioactive exposure that

we do.

Therefore, when we speak of undue risk to those generations, if we would quantify it, we're going to talk about something like what we would impose on a facility for today's releases, a ten millirem per year or 25 millirem per year, certainly something within the 100 millirem per year exposure envisioned in the new Part 20.

(Slide) Now, if you go to that basis -- may I have slide four -- you can do evaluations of the impacts in the human environment starting with the repository in the lower left there, the engineered barrier systems and what gets out of it and getting into an aquifer, groundwater transport. Then, when you get into the accessible environment, we have a long history in current facilities of analyzing contamination possibilities in rivers or surface waters, the food chain, getting into the different pathways. But the difficulty with the high-level waste repositories, we're not talking about the people who live there now or who would live there 50 years from now, but we'd be talking about the people who might live there 10,000 years from now or 50,000 years from now. That becomes an extremely complicated thing, not because we don't know how to analyze the

food chain pathway, but because we don't know how to postulate the future population and ground uses.

(Slide) If I could have slide five.

There is a more generic repository approach and in the EPA standard you will find this, where one can take a schematic of a repository and set it down where if you look down in the repository itself, your waste packages, you can have itemized standards for packages, overall release standards for the engineered systems, and Part 60, of course, you'll see has that. And then you get into the groundwater. Then, when you get to the accessible environment, you can set a release limit, a source term and stop there.

It is a simpler standard but in order to be confident that you have taken into account all the groundwater and air pathways in food chains, you might make a much more strict standard for that level of assurance. That, in fact, is a point often made about a release limit standard as being inherently more conservative in order to be more simple.

(Slide) Now, if I could go to slide six and let me just highlight the regulatory requirements we have. EPA has in their standards for the overall system a release standard, a source term limit. They have a ten thousand year basis of calculation and they

state the requirement probablistically. That's the heart of the controversy about the EPA high-level waste standard. The subject of the remand was basically the individual protection requirements in groundwater that are also listed. They are of a much shorter term and, as you probably know from the paper, they are stated in different terms and that was the basis for remand.

(Slide) If you turn now to slide seven, you have the NRC requirements for subsystems. NRC has a complementary standard to the EPA standard in that we have defense in-depth performance objectives where, going back to that cartoon in your mind, we have the waste package, 300 to 1,000 year lifetime. We have the engineered barrier release rate, that's the 10^{-5} per year after 1,000 years as a very small fraction of release and the groundwater travel time of 1,000 years.

In addition, and it's a vital addition, we have citing criteria and design criteria which are qualitative, judgmental, good practice sort of things that are needed to be there in conjunction with the performance objectives. So, the NRC requirements for the systems add up to a complementary approach.

(Slide) Now, if we look at slide eight and

look for pros and cons, starting with the concerns, many have said that the standards, in particular the EPA standards, are unduly restrictive. By simplifying with the source term the going to releases rather than doses, they give up some of the margin. It basically comes out, as we described in the paper, we're talking about 1,000 health effects in 10,000 years and that's a very low level of risk carried out to a very, very long period of time.

In the EPA standard that is stated, it is really codified ALARA. It's what a good site is supposed to be able to achieve. So, it is admittedly going below a threshold limit sort of standard.

The concern, and this is a major concern, is the possibility of paralyzing the regulatory process. Given that there is a referenced calculation over a 10,000 year period so the compliance calculation is for 10^{-4} years and one is forced by the words of the EPA standard to consider events whose likelihood may be fairly described as one chance in ten or even one chance in a thousand. Intellectually, people would immediately leap to it. 10^{-4} years, one chance in a thousand makes it 10^{-7}. I need a geological record of 10^{-8} or 10^{-9} in order to make that statement, in order to evaluate this thing. I'm paralyzed. I don't have

an adequate -- or may very well not have an adequate geological record because I'm approaching the age of the earth.

That is a very significant challenge because we're dealing with processes, geological processes in particular where you're looking at a geological record and folding it forward to extrapolate what might happen. In its most simple terms, if we have to predict a scenario that is volcanic eruption or an earthquake or something like that with any kind of precision at a probability level of 10^{-7} or 10^{-8}, we are indeed up against a formidable obstacle.

(Slide) Now, if I look at slide nine, there are some further things I won't dwell on, concerns about the standards where the terminology is not the same. That often happens and you should be aware that terms like "anticipated events," or "undisturbed performance," need a certain discipline to make sure that our standard and their standard are indeed talking about the same intent, the same meaning for a given term. And the treatment of human intrusion is quite difficult because it is even less quantifiable than some of the other things.

(Slide) If I could turn to slide ten, in contract to the concerns, there are some perceived

favorable features. The release limit, of course, does simplify the standard by eliminating the whole food chain pathway and population projection uncertainties. Having a compliance calculation based on 10,000 years, this is not to say that you don't look at 50,000 years or longer periods, but that the reference for compliance is a 10,000 period. That is a favorable simplification. Of course, if you go into the existing standard in the probablistic portion, you will find the phraseology similar to Part 60, "reasonable expectation of the outcome," "to the extent practicable," "quantifying things." It's not proof in the ordinary sense of the word. You will find qualifications that enable a judgmental use of these probablistic calculations and, of course, there is some guidance, especially on human intrusion. These are the favorable features of the standards.

(Slide) Just touching briefly in slide 11, both standards are up for revision, EPA standard because of the remand, and the NRC standards -- we gave you a paper about a year ago, SECY-88-285, in which the high-level waste rulemaking strategy was laid out. One of the key parts of it was all of the pieces of amending our standards to what it takes to implement the EPA standard and incorporation of the

EPA standard and related matters. So, both of these are on the table for revision.

(Slide) Now, I have slide 12 which talks about the need for performance assessment. But perhaps if we'd best go to slide 13.

(Slide) We're talking about a performance assessment, some comparative probablistic risk analysis in reactors. It's not so broad or so diverse a science. If you look at it, it is roughly analogous to the containment performance assessment in reactor PRA. There are no complex servomechanism subsystems, fluid systems, electrical systems here. So the whole core melt frequency or severe core damage frequency part is not relevant to performance assessment for high-level waste. Then, of course, if you simplify, the consequence analysis is not here. You're calculating a source term and basically you're dealing with containment event tree sort of matters, phenomenclogy. In the reactor, you're talking about whether core concrete interaction has certain characteristics. Here you're talking about geochemistry and things like that.

But one of the difficulties we have, and it's a pervasive difficulty, is performance assessment in high-level waste is going over this very broad time

horizon and drawing in much less certain phenomena. The core melt phenomena are uncertain because they're so hard to duplicate experimentally and to get meaningful data out of them. The uncertainty in the high-level waste comes from the source prediction out over 10,000 years or 50,000 years and we don't have a very strong database for that.

(Slide) So let me turn now to slide 14 and look specifically at the key probablistic requirement out of the EPA standard. The table is simplified. If you go to the paper or, even better, to the EPA standard, you'll see that this release limit in curies is pro rata. It's per thousand tons of heavy metal. So, if you're looking at a repository like Yucca Mountain, the overall release limit would be roughly 70 times this table value because Yucca Mountain has projected to hold 70,000 tons of waste.

The base of calculations for these releases is, as I said before, 10,000 years. So, the implementation of the standard uses that as a compliance reference but does not preclude looking at the longer time period for the perspective it provides and, indeed, in DOE's site screening analyses, they have looked at those longer time periods and we would expect to look at the longer time periods in the

licensing review, although there's no compliance level associated with them.

Now, a key thing, and I've reworded it slightly down in the bottom of the slide, we're talking about the probablistic nature and you could really divide events with adjectives and adverbs. You could say, there are likely events. There are unlikely events which are nonetheless considerable, worthy of consideration. And then there are unlikely events so unlikely as to be negligible.

The EPA standard uses a numerical adjective, I would call it, where they describe likely events as anything having as much as one chance in ten of occurring. I've written it as probability of 1.0 to 0.1. Their second category, excluding the first category, of course, would be --

COMMISSIONER ROGERS: Excuse me. You said "as much as." You mean more than.

MR. BERNERO: Yes. Yes, as much as one chance in ten or more than one chance in ten, yes.

Now, this second category, unlikely but worthy of consideration, they describe as having as much as one chance in a thousand and, of course, up to one chance in ten likelihood. I wrote it as .1 to .001. And then, by implication, anything less likely

than one chance in a thousand is off scale. It's not worthy of consideration.

The alternatives that immediately leap to mind are do we need to have the number or could we have just the adjective? Would that make this a more robust standard? Would that make the litigation of this standard in the licensing process more clear and more efficient? That's an obvious question and that is part of the question we have right here.

(Slide) Now, slide 15 is merely a graphical representation of that. I would rather go to slide 16 --

COMMISSIONER ROGERS: Excuse me, just on that. It wasn't clear to me what EPA ratio means.

MR. BERNERO: Oh, EPA ratio is just a way of saying that consequences --

(Slide) Put up slide 15, please, Karen.

If you look at the rectilinear line on this chart, the first vertical bar above 1.0 is that any event having a probability of 1.0 down to .01 has an EPA ratio of one, namely a release identical to the table or less. So, the ratio of the calculated release to the allowed release is one. Then, in the EPA standard, they permit for the less likely events which are the next vertical bar to the right running

from 10^{-1} to 10^{-3}. Then that vertical bar permits up to ten times the authorized release.

So, we use as a quick description of the consequence is an EPA ratio of one is the authorized source term for normal events or likely events and then any other EPA ratio would fall above it or below it as a description of the level of consequences.

CHAIRMAN CARR: That's clear to me. What's the second line on that chart?

MR. BERNERO: Well, the EPA standard is actually described by those two vertical lines.

CHAIRMAN CARR: Yes.

MR. BERNERO: And the second line, the curve, would be a hypothetical repository. When you calculate it, you would expect to get a curve of that general shape. If you ever look at a CCDF, a complementary cumulative distribution function for a reactor PRA, you will get a probability versus consequence plot just like this with a similar shape to the curve. They're generally concave downward.

CHAIRMAN CARR: But the location of that curve doesn't have any meaning?

MR. BERNERO: Oh, yes, it does in this case, to illustrate --

CHAIRMAN CARR: Except it's under the line.

MR. BERNERO: -- it would be acceptable.

MR. TAYLOR: It's just an example, hypothetical.

MR. BERNERO: Yes. It would be acceptable.

CHAIRMAN CARR: Okay.

MR. BERNERO: (Slide) Slide 16 really puts on what in any standard system are the questions you have to confront in doing a licensing review for a repository. What can go wrong with this repository? Obviously, you're selecting a site that's very normal, very stable, very deep. You want a high degree of isolation but you are forced by the nature of the safety review to ask what can go wrong and what are the consequences if it goes wrong, if some fissure opens up, splitting the repository in two or a volcano or a groundwater travel change of some sort.

Sooner or later, you've got to confront question number 3, how likely? How do you state it? Do you address it numerically or qualitatively? That takes you back to what I said. You can have likely, unlikely but considerable and so on, or you can have describable as at least one chance in ten, describable at least one chance in a thousand.

(Slide) Now, let's look at an example repository. Slide 17 is a table. Let me walk through

it. It's not in the paper. I think it will be useful. A real repository is going to have far more scenarios than this. Even if you consolidate the scenarios, I would expect to have at least a dozen scenarios on a real repository. But let's hypothesize a repository safety analysis where we have a baseline or normal condition. That's the expected configuration. That's the way we would leave it post-closure. Then we have two upset conditions, a fault movement, some seismic event, and a volcanic event. Again, these are hypothesized values. This is not a real repository.

We've got a compliance calculation over 10,000 years and we look at the likelihood and these multiple significant figures for the baseline don't imply precision, they just mean they are the difference between likelihood and the unlikely events. So, they're virtually a likelihood of one. We have for this hypothetical repository an EPA ratio of 0.1. So, on that grounds, that repository would be clearly acceptable. It's roughly an order of magnitude lower than the standard permits.

If we look at this hypothetical fault movement, we put in an asterisk just to make sure that there would be no doubt about it, it's a conservative,

upper-bound estimate for that one and you can exclude it from further consideration because even at a conservative upper-bound, it comes out with an EPA ratio of one, but it is an upset condition and merits permitting ten times the EPA standard so it's not limiting. Then we look at this other upset event, volcanic event, and we've got a debate. People are saying it's one chance in 1,000 or one chance in 10,000 and if we look at the consequences they could be 100 times the EPA standard level, whereas an upset condition by the standard should only be ten times. So, this would be a ten-fold exceedance of the EPA standard.

Now, at this probability, this event could be in or out of the debate. So, what this analytical process has done now with this hypothetical repository, it's focused our attention on the performance assessment of the volcanic upset condition as the crucial probability, the crucial issue.

(Slide) Now, if we turn to slide 18, I'm going to deliberately --

CHAIRMAN CARR: Hypothetically, of course.

MR. BERNERO: Yes. But I'm deliberately using here John Trapp's note of earlier this year. You know, our senior geologist wrote this healthy

skepticism note and said, "Hey, if I do model A and model B," and this is a summary of what he was doing on slide 18, there were two models or two alternate hypotheses to describe volcanism. In the early '89 period -- since that time DOE has evolved and they've got a lot of investigative program going on now, but in the early '89 period you could say, model A represented the DOE baseline model for volcanism and model B was the State of Nevada's consultant model.

Notice the difference. The one, the more optimistic model A says there was a single eruption that formed these volcano cones that are evidently there and we're at the tail end of the volcanic cycle. So things are quieting down.

The alternative model, in contrast, says, no, these are multiple eruptions and it's a cyclic thing. It's still going on. Well, if you graphically represent it --

(Slide) Now, slide 19, you're better off looking at it in your slide package than on the screen if you want to look at any of the print because we had to photo reduce it to get it on the screen. But really, this is a graphical representation of the alternate conceptual models that we just talked about.

First of all, the rectilinear line up at the top is once again the EPA standard and you're looking for analytical results that fall in the region below the standards.

Now, if you take model A, which is the lower box, and look at the parameters that enter into model A evaluations. By that I mean quantifying on the data available how big is the magma field, how old are the cones, all the different factors. We discuss some of them in the paper. If you quantify the range, you're going to get a variation in consequence and you're going to get a variation in probability, therefore some sort of a box or trapezoid to describe the range of outcomes.

Well, the model A box is well below the standard. The model B box, which is less sanguine, exceeds the standard in that region that you see sticking up the bold, black line, up above it. So, what happens now? We have an apparent exceedance of the standard and the issue can be addressed, are we dealing with the probability number explicitly or are we dealing and would the litigative process go to the underlying scientific bases for model B? How well do you know the age of the cone? How well do you know the size of the magma field? How well do you

scientifically characterize the cyclic nature, the recurring nature of this volcanism?

So, that's the real issue with the standard, whether the presence of the probability consequence discipline, using that as a discipline for analysis, whether the process will become paralyzed with the numbers or the process will instead use the numbers as a discipline to focus on the science. Of course, the objective is to do the latter, to focus on the science.

(Slide) May I have slide 20?

In the paper, we gave you four alternatives. Evidently, you could even go into the alternatives and make subalternatives of them. In essence, we're aware of the opinion that has been voiced recently about leave this part of the EPA standards alone and let's just do implementation in our standards, the deliberation in our standards. That is a subvariation that could go in here, leaving the current EPA standards, except for the remanded part. But basically, what the staff is recommending, the staff is recommending that we go with alternative 3 which not only looks at substantive revision of Part 60 in order to implement and clarify how the EPA standard is used, but looks toward very active interaction with

EPA so that the optimum implementation treatment and qualifications are incorporated in the EPA standard prior to its repromulgation. That's basically what we're saying.

In contrast, alternative 4 is the most extreme alternative and that would be for the NRC to take a different tact altogether and try to shy away from the EPA standards altogether and go essentially with a revised Part 60 to be the sole basis in hearing of whether or not the site is acceptable.

(Slide) So, if I turn to slide 21, the staff feels that given this good interaction with EPA in the repromulgation process and appropriate rulemaking and implementation work on our own standards, that we can achieve a useful probablistically based standard that won't paralyze the regulatory process and that will be a useful illumination of the high-level waste safety decisions in that process. Therefore, that's what our recommendation is and we leave it to you to endorse that.

I'd be happy to answer any questions and staff here, of course, is expert in this and has been involved in it for years, going back to the earlier controversies and we'll be happy to recover any of

that history you'd like.

CHAIRMAN CARR: That's it?

MR. TAYLOR: That's it, sir.

MR. BERNERO: Yes.

CHAIRMAN CARR: Any questions, Commissioner Roberts?

COMMISSIONER ROBERTS: No.

CHAIRMAN CARR: Commissioner Rogers?

COMMISSIONER ROGERS: Well, yes, I've got a lot of questions. We'll be here all day, I think.

First, some general questions. Is there a master list of basic underlying assumptions for these standards? Has anybody written down what the assumptions are behind each of these standards? Some of them are -- it's fairly obvious and some may not be so obvious.

For example, it seems to me that the focus with respect to human factors is the very negative aspects of human intrusion into a site. What about positive human intervention? The assumption seems to be here that future generations are going to be technologically impotent. Why don't we write that down if that's really what's behind it?

MR. BERNERO: Well, I think it's fair to say that there is no master list, but you will find in

places some illumination of it. Now, one of the reasons I put that underlying basis in the presentation is that would be one of the assumptions, that we assume future generations are equally vulnerable to cancer.

In the human intervention arena, we have just recently discussed as one of the needs is to get assumptions. For instance, if future generations are sufficiently smart that they can drill deeply into a geological formation, should we assume they're equally smart enough to recognize radioactive contamination when they hit it? That's an underlying assumption that would clarify the basis of the standard for human intervention.

COMMISSIONER ROGERS: Well, it would seem to me that it would be very helpful to understand what these really are because they're quite important and they're not at all clear and they're very fundamental with respect to some of these issues.

MR. BROWNING: I think the statement of considerations connected with each of the rulemakings is the place where in the case of the EPA standard, EPA laid out what the basic assumptions are beyond their rule. So, that would be the source of information. The same thing would apply for our

roles.

COMMISSIONER ROGERS: Well, it would be nice to see those, frankly.

MR. TAYLOR: We can put that together and get it to the Commission.

COMMISSIONER ROGERS: I'd very much like to see what our analysis is of what the underlying assumptions behind these standards are and whether, when they're all written down, EPA agrees that that's, in fact, what they were assuming. Maybe not. I'm rather concerned about this. It seems to me that we're dealing here with a very, very difficult situation, partly difficult perhaps because we're making certain assumptions that we haven't really clearly agreed upon that those really are what we believe to be the situation.

It's very nice to say that we believe future generations are going to be the subject to all the failings and frailties of current generations, but why don't we assume that they also have some of the skills and smarts that the present generations have? We seem to have turned off on that one. I'd like to understand that a little bit better.

So, that's a concern that I have that would give me a lot more comfort if I felt we all understood

exactly what we're talking about here. There's so much emotion and so much division on this whole question, I wonder if we could at least write things down that we commonly agree on or what we -- this basic starting plan for construction of these statements. If the NRC is going to have to write regulations that have to be imposed to satisfy those standards, then at least we ought to understand what it is that -- where we're coming from and where the standards came from.

So, I'd like very much to see that, if it could be done, and to see to what extent the EPA people agree that that's exactly what the assumptions are. You get them up to expose them to the full light of day.

MR. BERNERO: Yes. I think it would be very useful if we did a broad summation of all those and identify where there is consensus and where there is controversy.

COMMISSIONER ROGERS: Yes. So, some of these things, it seems to me to some extent, just seem to be written down but where do they really come from? I'd like to see that to a greater degree than I've been able to so far.

Talking about your approach here with

respect to probablistic calculations and the EPA ratio and coming back to slide 19, in using this, to what extent -- how are you going to deal with the assumptions or uncertainties really in those probability numbers themselves? We're looking here at something that I haven't thought a great deal about, but it seems to me that one can be somewhat deceived by these graphs and what they tell you. The EPA ratio, when it's above one, is really starting to get into trouble. The more above one it is, the more troublesome it is. Then you have this question of how low a probability do you consider for something that has a very high EPA ratio, and then what are the uncertainties in the calculation of that probability? So, what's the error band of this thing that one should be --

MR. BERNERO: If one had a very precise algorithm, that hypothetical chart that just had the sloping line, that would be the central estimate or the median or whatever it is and there would be an error band on it, there would be two shadow curves, one above and one below, to indicate the uncertainty.

In actuality, the EPA standard is much more simplistic. It's just two criteria boundaries. These squares are not really representative. They would be

a complex shape because they reflect a simple graphical presentation of the range of uncertainties within that model. So, given the hypothesis as in the fine print on slide 19, we're in a monocyclic, volcanic regime and we're at the end of the cycle, then all of the parameters that come into it give me this kind of a range in probability and this kind of a range in consequence and in this particular case it comes out, I don't have to worry about the precise shape of the thing because I don't encroach on the standard. I'm well within the standard's permission.

But with model B, I have to get more serious and say, what are those uncertainties or what are those variations that bring me up to the level of concern or limit by the standard and then I still have the words of the standard that the ultimate judgment of undue risk is, is there a reasonable expectation that even under these upset conditions that I envision, that this site and repository will be acceptable.

So, that exceedance there has to be --

COMMISSIONER ROGERS: Well, I think that's a good way to look at it. But another way to look at it also is that what you're talking about, and tell me if I'm wrong here, on models A and B that the centroid of

A and the centroid of B are both below the curve.

MR. BERNERO: Yes, they could well be. In fact --

COMMISSIONER ROGERS: I'm just assuming some kind of a step function distribution here to give you this square box.

MR. BERNERO: Yes.

COMMISSIONER ROGERS: So that the centroid of B is well below the curve and is acceptable and it's that little overlap area out there that you have to look at.

MR. BERNERO: Yes. And where I have to exercise the judgment which says, can I tolerate those uncertainties and still say there is a reasonable expectation that the site will perform acceptably?

CHAIRMAN CARR: But couldn't -- can I piggyback a minute?

COMMISSIONER ROGERS: Sure.

CHAIRMAN CARR: It looks to me like that B is "generally applicable," which is what the standards were supposed to be. It doesn't say it has to be applicable everywhere. It says generally applicable.

MR. BERNERO: I'm not sure I follow you.

CHAIRMAN CARR: That's what the law says, that they're supposed to make standards that were

generally applicable.

MR. BERNERO: Oh, yes. Their line, the heavy bold line that has the zig-zags in it is the standard.

CHAIRMAN CARR: Yes, but --

MR. BERNERO: B is the hypothesized perform --

CHAIRMAN CARR: B generally meets that standard.

MR. BERNERO: Yes. One might argue, it depends on where the centroid is. We don't have the data to do a more precise analysis, but one could conclude that generally applicable or, the way I put it, there is a reasonable expectation that it meets the standard.

CHAIRMAN CARR: Yes. I didn't read that it says that you have to meet it in every specific thing you can think of.

MR. BERNERO: That's right.

CHAIRMAN CARR: Excuse me.

COMMISSIONER ROGERS: No, that's fine.

Well, just coming at this whole question of probablistic standards, I know there's been a great deal of discussion about that and I'm not comfortable that we have really come to a total position on how we

feel about these probablistic standards. I know just within the last six months or so the kind of impression that I've gotten of staff feeling about the probablistic standards are that they're very difficult to deal with and at one point some people have said, well, they're almost impossible. And now we're beginning to hear that, well, we feel that we can deal with them.

But I wonder if we could just talk a little bit about that. In coming to a set of probablistic standards, did EPA consider alternatives to that? Do you know what they considered? Did they -- how did they come to a probablistic standard versus, say, a more deterministic approach?

MR. BERNERO: Seth, would you or Dan like to speak to that one?

MR. COPLAN: Let me start. I think Dan has had pretty extensive involvement with the EPA over the years, so let him elaborate.

But the approach that EPA took in terms of a probablistic standard is something that they started quite a few years ago. I think there were working drafts going back, to my knowledge, as early as 1979 that had this basically probablistic flavor to them. At that time, the Commission staff was really pretty

strongly in disagreement with that type of approach. We tried to encourage EPA to develop standards that addressed this issue of likelihood of upset conditions in a more qualitative way. We also tried to have them focus on things on an individual scenario basis rather than collectively in the form of this curve that brings together both normal conditions and upset conditions.

I think what was really part of, in a way, a telling consideration over time to us is that EPA was looking at the standard in a way as if you had somebody standing at the edge of the accessible environment, collecting radioactivity over a 10,000 year period. They were putting a standard on that and, as Mr. Bernero described, they were focusing on the radioactivity as a surrogate for dose in an effort to kind of simplify what we'd have to deal with.

So, you have this guy, he's standing at the edge of the accessible environment collecting radioactivity for 10,000 years. On average, he would be collecting normal scenario types of releases, but also in a certain sense there would be some upset conditions. What they were figuring is kind of weighing it in on the basis of the frequency of occurrence or probability that these events would

have. I think over a period of time, the staff that were most directly involved with EPA began to become convinced that perhaps this was a good way to establish a standard and I think with some of the points, again, that Mr. Bernero made about how if you keep the focus on the scientific basis for the numbers, that it would probably provide also a good discipline for doing the licensing.

Dan, would you want to add anything?

MR. FEHRINGER: Yes. I'd like to emphasize that there was a great deal of interaction between the NRC staff and EPA staff on exactly this point, is a numerically probablistic standard workable or would some alternative be preferable?

We spent a great deal of time and effort trying to conceive and articulate an alternative that was clearly preferable and we could not find one. The best alternative we were able to come up with was what Mr. Bernero alluded to, get rid of the numbers and use words instead, words like "likely," and "unlikely." What you gain in flexibility, you lose in precision when you have a standard expressed that way and we didn't see that the tradeoff was clearly beneficial in that case.

CHAIRMAN CARR: Let me piggyback on that one

too.

Has anything changed since the NRC developed the rationale for Part 60 and NUREG CR-235 to make us now doubt the implementability of EPA's current containment standards? What's new, I guess, since we decided we could do it this way?

MR. COPLAN: I think that the one thing that is new is, of course, there's been more experience in dealing with real sites. The standards were based by doing calculations on hypothetical sites. Since this earlier period when the standards were taking form, there has been more direct investigation of the WIPP site, of Yucca Mountain site, the Hanford site. So there's been some experience and a recognition that certain things might be a good bit more complicated than the hypothetical sites would lead one to believe.

However, I think also at the time that the standards were developed, there was a recognition that these hypothetical sites were oversimplification. So, I think what we're finding at this point is that, yes, there are going to be some difficulties when you get down to really trying to figure out how, say, this volcanism situation works well enough to start putting numbers around it. But at the same time, I think that on balance we still think we can do it.

MR. TAYLOR: I'd like to add and perhaps Bob would too --

MR. BERNERO: Yes.

MR. TAYLOR: -- that I think Seth said it, but I'll say it again. We've had much more experience dealing in the PRA arena in intervening years. That's a fact. And on the reactor side where we've been working hard, as you know, for many years, studies like NUREG 1150 and so forth, the work in progress has increased the staff's understanding of the applications and even in that arena the external events and remote type events such as seismic events of great magnitude have, I would say, increased the staff's appreciation of the range of predictions by expert opinion and its effect on probablistic distributions.

Bob, have I tried to capture maybe the --

MR. BERNERO: Yes. I'll pick up on that. As you know from NUREG 1150, the codification of expert opinion, very controversial, very difficult, and recall that I made the comparison in the briefing -- performance assessment is very much like containment performance assessment, very difficult part of reactor PRA. But I would like to go back. That gives you proper and due caution.

But nevertheless, what Seth said earlier is worth repeating and perhaps another way. From time to time in history, a panel of experts can be drawn together and they will say that deep geological disposal of high-level waste is technically feasible. If you get that panel of experts and say, "Is this high level waste acceptable in that hole in the ground," they suddenly start to agonize over the decision. I think there's a very large part of that too.

So, we have this experience on the reactor side that has entered in and made us a lot more cautious about quantifying expert opinion and, at the same time, we've got a lot more site specific information. We've got these slides that, here's the volcanos at Yucca Mountain. Let's talk about them and not some hypothesis. So, you get a lot closer to the decision.

COMMISSIONER CURTISS: Let me pursue that just for a minute because I guess one of the things that troubled me about the paper was what appeared to be some tension between a couple of schools of thought.

What you've described here is a conclusion that the Agency had reached pretty much in '85, that

the probablistic, quantitative EPA standard can, in fact, be implemented so long as we understand that what we're seeking here is reasonable assurance and not expecting proof in the ordinary sense of the word in our proceedings. So, we had reached that point in '85 and the language reflected reasonable assurance and proof in the ordinary sense was incorporated in both the EPA standard and the 10 CFR Statement of Consideration.

I guess the question that I have at this point, given your recommendation, it does indeed appear to me that you are less confident today of your ability to demonstrate compliance with the EPA standard if you take a look at the recommendation that you're making. What you're essentially saying is, if I distill it to its essence, is that assuming no change in the containment criteria in the EPA standard, that we need to go back to EPA and secure additional clarification of a qualitative nature, work something out with EPA that would clarify to a greater degree than we did in 1985 and with emphasis upon qualitative considerations just how it is that you would meet this probablistic standard.

Now, for that reason, and the tension that I guess I detected in the paper was one that seemed to

suggest that because of the emphasis on the need for further qualitative guidance on the implementation beyond what we reached agreement on in '85, it appeared to me that you were moving away from as much reliance on the probablistic approach as you envisioned in '85. Can you clarify that for me?

MR. BERNERO: I'd like to speak to that. I tried to cover it in the briefing and perhaps not adequately. There are two sources of tension that should be apparent in the paper and apparent in the alternative.

On the one hand, there is the question of whether the existing words of the implementation character of the probablistic EPA standard, the reasonable assurance, reasonable expectation, the not proof in the ordinary sense of the word and so forth, whether those are sufficient qualifications to avoid numerical paralysis of safety review or whether know some better, some much more knowledgeable qualifications based on specific consideration of how to implement the standard, the sorting of events, the quantification of human intrusion and the very real problems, whether better qualifications or more specific implementation language in the EPA standard is needed. But notice, in both cases it's a

probablistic standard.

COMMISSIONER CURTISS: I understand that. But --

MR. BERNERO: So there is that tension and at the same time there is a real tension of those who say, "Are you sure you can succeed and should you not go to alternative 4," and say you aren't going to get there from here, you've got to go out of probablistic space into bounding analysis, judgment, a much more deterministic analysis.

CHAIRMAN CARR: But if you ask that question, you may not like the answer. Currently, it looks to me like you've got a lot of leeway. Your statement in the paper says NRC is responsible for licensing the disposal repository but it's licensing judgment must be based on compliance with the EPA standards. But when I read it, it says but its licensing judgment must be not inconsistent with the EPA standards. That's what we're required to be is not inconsistent. That's a lot of leeway.

MR. BERNERO: Well, you could go back. In fact, I don't know if you had a chance to have your staff look at the -- you asked a question about the underlying basis if Part 60. There is a detailed analysis in whatever SECY paper that was four years

ago that talks about our present Part 60 with the linkage of basically three deterministic performance tests with a set of judgmental good geological qualities and bad geological qualities and design criteria. That mixture might, in itself, be sufficient.

If you go to that analysis of Part 60, it basically shows an analysis to establish reasonable confidence that this Part 60 does indeed hold out a reasonable promise of satisfying the EPA standard. One is at the edge though of saying, "Could I say with assurance that I don't even have to do the performance assessment of the EPA standard," in other words, the probablistic display, "that I could use only the deterministic and judgmental."

If you look at that analysis, I'm afraid that the parameters of deep geologic disposal are not so free or not so forgiving. I think you would end up, if you look at that data and I was pondering this myself some time ago, that you would end up not with a 1,000 year groundwater travel time, but a 10,000 year groundwater travel time. You would not end up with a 10^{-5} per year release fraction, but something more like 10^{-6}. And the same thing with the package lifetime.

In order to have that kind of confidence that you could virtually go to alternative 4, you'd have to go so conservatively that you might rule out all the good sites.

COMMISSIONER CURTISS: Let me make sure I understand what you're saying.

CHAIRMAN CARR: I'm not sure -- I don't agree with that statement, but I understand it.

COMMISSIONER CURTISS: Are you saying that if you demonstrate compliance with the subsystem performance criteria, that with the exception of the margin question, that you have complied with the EPA standard?

MR. BERNERO: No. If you go to the backup for the promulgation of Part 60, it says -- it's justifying a regulation which says, "Here are alternate ways to analyze the site in conjunction with the performance assessment." So, you actually have the two. You have the two together. The alternate way, the Part 60 way, is a defense in depth three performance elements and a complementary set of judgmental qualities, good geology, bad geology and things like that.

But the underlying basis is that you need both. What I'm trying to describe is what would it

take to make a generic finding that if you meet the deterministic standards alone, it is evident that at any site you're going to meet the probablistic standard. That, unfortunately -- we've talked about this before. When you go to deep ocean disposal, the system may be so simple and may be so forgiving, that you could make such a finding, but that's hypothetical. It's not a practical solution.

COMMISSIONER CURTISS: Let me take a hypothetical. If you had a DOE application that proposed 10,000 year container and 100 year groundwater travel time, would that meet the EPA standard?

MR. BERNERO: Yes, it could. Some combination of a very good container and a very poor site, but it wouldn't meet our standard.

COMMISSIONER CURTISS: Well, I guess that goes back to a fundamental question that I have. That is that, stated in its simplest terms, if the folks at EPA are to set the standard for protection of the public health and safety and were to implement that, I guess I haven't understood what the relationship is of the subsystem performance criteria to the EPA standard. They're not questions that go to how you implement the EPA standard because at that

hypothetical you've got a situation -- you've got a proposed approach to defense in depth that would meet the EPA standard, but it would not comply with the requirement 60.113 that you have a 1,000 year groundwater travel time.

MR. BERNERO: I believe we referred to it in the paper somewhere. The EPA standard does have the understanding or expectation that we will have defense in depth without undue reliance on, let's say, the package or the groundwater.

COMMISSIONER CURTISS: I'm not objecting to the defense in depth principle. What I'm focusing on is the articulation of that principle in the kind of detail that 60.113 contains. There's a situation where if you came in with a container that far exceeded the 300 to 1,000 years that we require in 60.113 and you wanted to take credit for the investment that you make in, say, a copper container to achieve that by saying, "Because of the performance of that container, I don't have to demonstrate 1,000 year groundwater travel time and all the complications that the geological challenge associated with that will pose," you can do that under the EPA standard. In other words, you have met EPA's articulation of protecting the public health and safety, but you

cannot do that or at least you're not permitted, absent Commission intervention under 60.113, to do that.

MR. BERNERO: I would prefer to ask Seth not to nod his head --

COMMISSIONER CURTISS: He's shaking his head. Did the reporter note that he's shaking his head?

MR. BERNERO: -- to use the words you said. You have demonstrated in that long-lived container that you can satisfy perhaps the containment requirements of the EPA standard, but it remains to be judged whether those defense in depth implementation factors or details that are properly dealt with by the NRC in its regulation and its licensing, are fairly treated. It would be in our safety analysis whether we would give 10,000 years or 100,000 years credit to the copper can or whatever it might be.

COMMISSIONER CURTISS: Well, assuming that there's reasonable assurance -- and I'm stipulating that for the purpose of the hypothetical -- that you've got a container that can last for 10,000 years and you can demonstrate that to the licensing board, assuming that as a point of departure, what you are saying in addressing that hypothetical is that the EPA

regulations can be satisfied and the public health and safety can be protected in the manner that Congress has charged EPA to articulate in the standards. But because of the structure of 60.113, that hypothetical, which does involve a mix of defense in depth, would not meet our standards.

The conclusion that I draw from that is that we have articulated or expressed in 60.113 not just a framework for implementation of the EPA standards, but a separate and in this case in consistent standard under the rubric of defense in depth.

MR. BERNERO: The closest analogy I could make, and perhaps it would illuminate this, go into reactor land, potentially controversial. A safety goal for a reactor would call for an off-site risk of some low level. We are faced, and it's a very difficult question, with the possibility of a reactor whose likelihood of severe core damage is so low as to moot the need for a containment. It's like a can, a very, very good waste container and mooting the need for a particularly good site.

The EPA standard is not so simplistic as to say, "Here is a safety goal. That's all it is." It has certain words in it and certain bases that require you to take due account of the frailty of those

calculations. Our regulations and our responsibilities are very comprehensive and it is in that arena that we have this highly structured defense in depth thing and the significant responsibility of deciding where can you hedge and where do you not hedge. You can go in our standards and we say, "300 years to 1,000 years of package lifetime." There's another passage that says, "Take a look above that and see whether you can exploit the package to get more margin." That's part of defense in depth.

COMMISSIONER CURTISS: But the margin is built into the EPA standard when -- as they have decided that you want to have one-tenth of a health effect per year, that's the margin. That's compared to -- I disagree with the statement in the paper that that's comparable to what we do with reactor risks. I think that's just flatly incorrect. But it does seem to me that the question of margin and conservatism is built into the EPA standard with an approach that we acceded to, not because it had a basis in some sort of assessment of a risk, but because it was achievable. And then to articulate that you want a separate one on conservatism that is based upon the principle of defense in depth that leads you to very challenge that you're going to face here, demonstrate groundwater

travel time of 1,000 years is going to involve these complications on the performance of a geologic medium. Not only that, but more parochially, it gets us into the need for the rulemaking initiatives uncertainties when you define what groundwater travel time is and what substantially complete containment is.

We're going to address or the staff is proposing that we address a whole range of uncertainties that derive from the set of subsystem performance criteria when they may not have any nexus to the EPA standard.

MR. BERNERO: I think you're presuming that the margin in the EPA standard by going from a dose standard to a release standard is amply available for the uncertainties in the calculation. I'm not sure it is. There has been concern that the release limits, the margin purportedly associated with the release limits, is needed to cope with the variability of the standard, the dose standard implementation that-- Yucca Mountain has no one living there. Some other site, if you came in the Eastern Seaboard with a repository, you could have a fair population living right around the site. What they've done is paid a price for simplification. But technical analysis of the EPA standard in the past has shown that simply

representing the release alone, if all of that release came in one little rivulet of water that went to one farmhouse, you could kill the people.

COMMISSIONER CURTISS: I agree.

MR. BERNERO: Or if it went into the Pacific Ocean, no one would get a health effect.

COMMISSIONER CURTISS: But the margin exists in part because Congress has selected Yucca Mountain where there aren't any people living around the site or a significant -- not as many as Minnesota, for example.

MR. BERNERO: But we don't realize that margin in this case, if it be there, because we paid a price to go -- we collective, the U.S., by using a release standard, have obviated the need to model who will live at Yucca Mountain 20,000 years from now.

COMMISSIONER CURTISS: Yes, I understand. I don't want to pursue it in a whole degree of detail here. I guess the thing that puzzles me about the paper and the tension that I detected is that we seem to be saying in 60.113 that we do, in fact, have a separate -- you've described them as complementary, but the hypothetical, I think, may suggest that they are, in fact a separate set of criteria, the 1,000 year groundwater travel time, 100,000 release rate and

the 300 to 1,000 container, that if you demonstrate that you meet those, you don't meet the EPA standard.

So, in effect, we have set up in 60.113 a set of standards, call them generally applicable if you will, but they are a set of standards that are designed to address the risk to the public health and safety. That strikes me as EPA's job. Additionally, the complications that we are facing today in demonstrating that you meet those three subsystem performance criteria, including the regulatory uncertainty question, and the skewing of the balance that the applicant might strike in the defense in depth area, the 10,000 year container, seem to me to make that -- seems to me that that's a reason to take a careful look at 60.113 in the first place.

So, on the one hand, we've got a set of NRC criteria that really do establish principles for the protection of public health and safety. At the same time, what the staff, I take it, is proposing is that with respect to the EPA standard, we go to EPA and we ask them to include additional guidance in their standard qualitatively on the implementation of that standard. I guess jurisdictionally, if nothing else, that strikes me to be a responsibility that we ought to have and not EPA.

So, it looks to me like maybe we've, in each of those areas, taken an approach that frankly I don't understand.

MR. BERNERO: Well, that's the tension I was trying to refer to. Given that there would be these two orthogonal and, I assert, complementary standard systems, that the EPA standard would have further details added to it that would acknowledge or recognize the implementation needs or content of the NRC standards and actions.

COMMISSIONER CURTISS: Why don't we put that in our regulation as an implementation --

MR. BERNERO: Oh, we clearly have to. Our big three rulemaking. Our big three rulemaking, how do we categorize --

COMMISSIONER CURTISS: No, no, I'm not talking about the uncertainties. I'm talking about the question of how you implement the EPA standard, jurisdictionally if nothing else. The EPA sets the standard and we implement it. Doesn't that suggest that those criteria on implementation qualitative, as you're proposing, ought to be in the Commission standards and they ought to be a matter for the Commission, not EPA, to decide?

MR. BERNERO: Well, that's the view that

says, the EPA standards as they stand now are sufficient, aside from the remanded part, and that further implementation discussion and delineation belongs in the NRC rulemakings and standards and that, of course, is a possible outcome of alternative 3.

COMMISSIONER CURTISS: If the EPA standards are sufficient -- and I don't want to go on at length about this. But if the EPA standards are, in fact, sufficient, if there's nothing inherent in the standard that demonstrates that in a hypothetical context it can't be met by a repository somewhere, that as a theoretical matter you can go through the intellectual process of demonstrating compliance. If that's true today, and I take it the staff is saying that it is, then if there are additional details that need to be explained about the implementation of the standard, including details that go beyond what we said in '85, my own view is those ought to be in the NRC regulations because they are matters of implementation and they are not matters of establishing a generally applicable environmental standard.

MR. TAYLOR: That's possible outcome.

MR. BERNERO: Yes. You're not alone in that view and --

CHAIRMAN CARR: I need to ask one question, Is it your position, Jim, that the current NRC standards are inconsistent with the EPA standards?

COMMISSIONER CURTISS: I guess my own view is that as I look at 60.113, it doesn't seem to me that that set of standards is a translation or an articulation of how you implement the standard. Take one example, the one that we talked about earlier. There's a case where you could meet the EPA standard, but you can't meet 60.113.

Now, I think it's been fairly clear all along as we've looked at the subsystem performance criteria that, as the staff said as early as '81, that if you meet the EPA standards, you don't necessarily meet 60.113 and vice versa. In the division of responsibilities between the two agencies where EPA sets the general standards and we, in turn, set up a framework for how you implement that, I'm puzzled that you can reach a result that could meet the EPA standard as a technical matter, but does not satisfy the set of implementing regulations.

CHAIRMAN CARR: The Act requires us to not be inconsistent with EPA standards.

MR. BERNERO: Yes, but at the same time--you know, there's a phrase we used to use in reactor

regulation that these are orthogonal ways to analyze safety, that in the performance assessment, EPA standard, we have a mechanistic model of all the events and processes and what their outcomes would be and we have a best estimate of what the outcome is.

In the NRC standard, we approach it from a totally different way and we have a building block, defense in depth and all these qualitative things and that they both purportedly come out with an acceptable site. They are very different. They are orthogonal in the way they view --

COMMISSIONER CURTISS: They're inconsistent in the hypothetical that we talked about.

MR. BERNERO: Yes, but the result and the measure of an acceptable disposal site is that by the orthogonal analyses we have found it acceptable both ways.

CHAIRMAN CARR: We're required to be not inconsistent.

MR. BERNERO: Yes, and not inconsistent, but with sufficient confidence to satisfy our responsibility to say in that unprecedented thing, "There's no undue risk for people who are going to live here tens of thousands of years --"

COMMISSIONER CURTISS: Let's make it clear.

When the applicant comes in today and the applicant today, assuming the EPA containment criteria is finalized as is, and the applicant is going to have to demonstrate two things, not one. They're going to have to demonstrate that they comply with the EPA standard and they're going to have to demonstrate that they comply with 60.113.

Now, I agree with you that that approach gives you a greater degree of confidence in one respect. But at the same time, it has led to the lesser degree of confidence because we're now forced to litigate the uncertainties that derive from 60.113. Simply from a legal perspective, having to demonstrate two things rather than one is going to complicate the licensing proceeding. I'm not opposed to that if you can demonstrate that you meet the EPA standard by demonstrating that you meet 60.113, but that's not where we are.

CHAIRMAN CARR: I would recommend we turn back to Commissioner Rogers. We're working on his time.

COMMISSIONER ROGERS: These are all still very interesting questions to me, that's why I haven't complained. But I think that this model that you've described, Mr. Bernero, for orthogonality with respect

to these two ways of looking at it, I'm not sure--maybe you're right, but I don't necessarily buy that that applies here and I'm not sure whether there isn't some congruence here and that's part of the problem, that they really aren't orthogonal.

To me, an orthogonal set, they're independent. They're totally independent. If what we're seeking is, in our axis of orthogonality, of one of the two orthogonal axes, a more qualitative approach, then I can understand that, that what we're seeking is some interpretation allows us to apply qualitative measures in addition to the quantitative measures which come out of the EPA standards. This is the way I'm looking at it. Maybe I'm wrong, but I'm looking at it more from that point of view.

If what you're trying to do is get some agreement from EPA that there is an additional way of interpreting these things, that allows the introduction of qualitative judgmental factors, expert opinions or whatever. I don't know how you're going to go about doing that. I'd like to hear a little bit more about how you, in fact, want to do that. But that I see as two independent axes for judgment here in a new space to put these things.

But I'm worried that maybe what we have is

not exactly that, but we do have the possibility of overlapping requirements that Commissioner Curtiss is talking about.

MR. BERNERO: I need to acknowledge -- you are absolutely correct. They are no less orthogonal than reactor safety analysis and PRA are because reactor safety analysis has buried in it things like the no single failure criterion which are veiled reliability or probability measures.

But you're right, the defense in depth elements of the package and so on have a certain commonality to a mechanistic analysis or realistic analysis of what could happen.

COMMISSIONER ROGERS: Well, I don't know that we have the time today or really are prepared to do it, but I would like to know more about how you intend to deal with these uncertainties in the probablistic area and whether you intend to use an approach such as was used in NUREG 1150 of some kind of collection of expert opinions brought to bear on producing some kind of judgments or just what you intend to do, how you intend to get those distribution functions that are relevant to each one of these probablistic assessments. I hope we could learn a little bit more about that.

MR. BERNERO: Yes. That's a very important field and that's --

COMMISSIONER ROGERS: But how you're going to do it, I think, is very important.

The other thing is, just sort of jumping more toward the end of my list, it sounds to me from what you've just said in terms of staff's recommendation is alternative 3, that that's in disagreement with the recommendation that was in SECY-319, which was an alternative 1 which, I think, if I'm correct there -- am I mistaken that the recommendation out of SECY-319 was essentially alternative 1?

MR. BERNERO: If you look at alternative 3 on page 12 of the SECY paper, this was the difficulty of how many subalternatives we would put in the paper. We said current or revised EPA standards and we weren't referring to the part that needs fixing from the remand.

MR. TAYLOR: That was in recognition that indeed the current standards may be as good as you can do, accepting that the initiative wasn't further qualification appropriate. This grows out of the tension discussion that exists within the staff and, I think, others.

Part of the management of this process has

been to, from an EDO standpoint, recognizing this and recognizing that there may be time and this might be a good time to look at the EPA standards and the way we proceed further with rulemaking and bring to bear the knowledge that we have gained in the past few years in the reactor side, bringing all those together.

This started about a year or so ago when sort of a broader band of the staff got more deeply involved in this. It was all those things together that brought us to say, we need to come to the Commission and lay this issue out. We don't have all the answers at this time, clearly. We may not even be able to make the EPA standard better. If we don't, then we face our own rulemaking process, as you outlined, Commissioner, to try to work this problem through.

It is a knotty problem because of the probablistic aspects. That's the general agreement about it being knotty. We face some years down, if not for this repository, but the recommendation for a revised -- or in the process of litigation that will prevail and we're trying to do the best job here early on that we can to get the clarification, to get the thoughts in place, the best we can do in 1989 to work this problem, to solve issues now if we can.

CHAIRMAN CARR: Well, you talk on page 17, "The staff anticipates this resolution will consist of modifications to the EPA standards and NRC rulemaking."

MR. TAYLOR: Yes.

CHAIRMAN CARR: Do you know what modifications you need?

MR. BERNERO: For their standard?

CHAIRMAN CARR: Yes.

MR. BERNERO: That's not clear. But the preponderance of what is needed is described on page 13 of the paper where in alternative 3 we spoke of the great scope and depth of the rulemakings that NRC has to do and we've enumerated some of the details, not that we have the answers.

CHAIRMAN CARR: Well, you referred that we learned a lot from WIPP. What have we learned specifically? Is WIPP going to be able to be licensed under these standards? Are they going to meet them?

MR. BERNERO: Unfortunately, the WIPP schedule has slipped and everyone's been watching vigilantly because the same standard would be applied and we believe the mechanism is in place whereby the Department of Energy would publish the performance assessments and analyses that go toward implementation

of the EPA standard in a supplement to their environmental statement.

CHAIRMAN CARR: So nobody has any indication that there's a hangup on WIPP.

MR. BERNERO: But the best information we have now is that it's been put off until '92 or '93.

MR. BROWNING: 1992.

CHAIRMAN CARR: But we haven't pinpointed some problem with those standards from WIPP?

MR. BERNERO: No.

CHAIRMAN CARR: Okay.

COMMISSIONER ROGERS: So we don't know exactly how we're going to revise Part 60? Is that what you're saying?

MR. BERNERO: Not yet.

COMMISSIONER ROGERS: Okay.

MR. BERNERO: But the key rulemaking --

COMMISSIONER ROGERS: But it's opening the possibility up, but you haven't --

MR. BERNERO: Just by way of example, the key rulemaking in some respects is going to be how do you classify events? Do you have situational criteria which say, "These are the criteria by which you judge whether an event is in the bin likely or unlikely but worthy of consideration or so unlikely as to be

negligible," that you would use situational criteria and that you wouldn't run out to a seismologist and say, "Give me the probability of an earthquake of this magnitude," that you would use the probabilities as a description. But you need a structure for that. That's very difficult to do.

CHAIRMAN CARR: Does -- the EPA may not want to address any changes to those standards since the court seemed to buy those. Does that have any effect on what we want to do, the fact that the standards weren't found effective in the court decision?

MR. BERNERO: Are you referring to any discussion of the groundwater and individual protection part or the probablistic part?

CHAIRMAN CARR: I'm just saying that the standards, per se, weren't -- the probablistic part wasn't found effective.

MR. BERNERO: It was not remanded. In other words, it just didn't come into the remand. But nonetheless, EPA, in working draft number one for the repromulgation of the standard, following their previous practice, has shared working draft number one with us and with others to solicit constructive comment. We do have a healthy dialogue with them on that. We expect to see their working draft number two

very shortly.

COMMISSIONER ROGERS: I'm finished.

CHAIRMAN CARR: Commissioner Curtiss?

COMMISSIONER CURTISS: Are they proposing in that draft to reopen the containment provision?

MR. BERNERO: Some -- yes. In working draft number one, there were some things and we're discussing that very point.

COMMISSIONER CURTISS: Even though the court did not remand on those issues?

MR. BERNERO: Right. And the staff, probably a year or two ago, I know I've said it at this table, that we were prepared to leave well enough alone and sort of freeze those parts of the standard as is and live with it. And there's still a substantial view in staff that we may end up that way in alternative 3, that those qualifications or implementation details that are already there may be sufficient.

COMMISSIONER CURTISS: Well, regardless of whether they reopen the containment provision and recognizing that that was not remanded by the court, I guess I'd be inclined to say that at this point, particularly if they do, and given the hiatus in the program that we have now, I think as Commissioner

Rogers has alluded to, it would be an opportunity to go back and look at a number of things. He's mentioned the underlying premise he's for the approach that we've taken.

I guess the matters that are of greatest interest to me are discussed in some detail already. I continue to be puzzled about the connection between the subsystem components criteria and the EPA standard. I do not think that -- well, put it differently. If the subsystem performance criteria are, in fact, the means of articulating how you meet the EPA standard, then it seems to me that that's consistent with the Agency charge under the statute.

If they're not, if they're in fact a separate set of criteria and that they can provide an additional different degree of confidence in the decision that we're reaching, it doesn't appear to me though, A, that they are essential to ensure that the defense in depth approach: I think we've past that point. And B, that additional degree of confidence, proving different things in a different way, has some costs associated with it, the uncertainty of rulemaking, the complications in the litigation, and the ability to meet the three year licensing period.

In addition, they have, as we talked about a

hypothetical, they have an impact upon how DOE might strike the balance in achieving the defense in depth between the container and the geologic medium.

So, for those reasons, I'll be encouraging you to go back and take a look at 60.113 and, given where we are today, to reexamine the continuing need for that set of the regulations. I guess that's an issue that we ought to take a look at.

I also think it's appropriate at this point, particularly if we're going to reopen the containment standard, to take a look again at this underlying risk basis for the EPA standard. For the first time, I think the staff is saying in this paper, for the first time that I'm aware of, that the EPA standard is, in fact, comparable to the other kinds of risks that we regulate, particularly in the reactor community. I've always understood, or it's been my impression, that the EPA standard was something that we agreed to not because of its approach to risk, but because it was simply achievable, DOE's facility could meet that standard. That's an issue too that at some point we might want to take a look at.

CHAIRMAN CARR: Anything else?

Thank you, gentlemen.

We'll get Doctor K uts up.

Welcome, Doctor Kouts. You may proceed.

DOCTOR KOUTS: Thank you very much, Mr. Chairman.

Let me begin by correcting one thing which you said when you mentioned my presence earlier. The Defense Nuclear Facility Safety Board is not part of the Department of Energy. It's an independent agency.

CHAIRMAN CARR: All right. I stand corrected.

DOCTOR KOUTS: With oversight over the Department of Energy.

CHAIRMAN CARR: Thank you.

DOCTOR KOUTS: As you may well be aware, I'm here today not representing the Defense Nuclear Facility Safety Board. I'm here to state some opinions of my own which I've developed over a number of years. In fact, the Defense Nuclear Facility Safety Board cannot really have anything to say about any matter which is under the purview of the Nuclear Regulatory Commission and it's prohibited by law from doing so.

I would like to make a logical case for what I have to say by covering some ground which I'm sure you are well aware of and you'll forgive me if I say some things that you well understand.

In talking about PRA first of all as it's

applied to nuclear power plants, because this is the derivative of -- that is the application to a waste facility would be a derivative of the application to the nuclear power plants.

As you well know, the input data which go into the analysis for nuclear power plants have large uncertainties attached to them and are represented by large, wide distribution functions on the probabilities that enter into the calculations. These are the results of many things, human factors, difficulty in predicting rare events, the difficulty in applying engineering calculations to very difficult -- to very unusual engineering situations and extreme physical conditions.

The result is relatively large uncertainty bands in the results. The distribution functions on risk have very wide bands attached to them as well. For this reason, the Commission has wisely refrained from placing bottom line reliance on PRA results in its determination of safety in the nuclear reactor field.

It's realized, however, that PRA offers the only quantitative answer to the question of how safe a certain situation or a certain thing may be. So, PRA is naturally brought into the process of a

determination whenever this question comes up, as it often does, but the uncertainty bounds have to be kept in mind.

The Commission has said that it will simply not judge the safety in the specific reactor case on the basis of bottom line PRA numbers. This is the wise conclusion. Sometimes it's said that the bottom line results will not be used in specific cases.

Now, in its implementation of safety goals, the Commission has said that the results of PRA will be used as one item in a final determination of whether safety goals are met. This would recognize the uncertainty bounds. But also included in such a determination would be such things as deterministic safety analysis, the safety culture which might be determined to exist in a certain situation, SALP results and other input data of that kind. So, this has been the basis for determination of safety in those cases.

Now, let me turn to the question of waste. Here, the PRA problem is substantially different. You don't have mechanisms whose success or failure of operation is going to be the basis of a determination of the outcome of a PRA. Instead, you have conditions that you expect to exist at a waste facility. That is

the way the operation will take place, the way the facility will be constructed, and you have to take into account, of course, as a very large factor, the natural events that might occur and might influence the effectiveness of the repository in the future. These events are, as has been said earlier this morning, such things as volcanism, floods, hydrological changes, changes in climate, and many things which occur over a great many years.

Now, EPA has recognized the difficulty in prediction of these things. Following discussions with the NRC staff in which this was a large item of discussion, the EPA has agreed to the concept of reasonable expectation or reasonable assurance as a basis for entering probabilities of this kind into the calculations that PRA may have for a waste repository.

Even here, however, there will be disagreements on the implications of what is found as they are entered into the calculations. Disagreement on what the physical record shows. This has already occurred at such proposed facilities as the one at Hanford earlier, which the Department of Energy has put aside, and at Yucca Mountain, where there are disagreements on implications of past volcanism and post hydrological conditions.

The PRA results are going to reflect uncertainties of this kind. I am quite sure that when -- and this will occur in the future -- when the NRC staff has carried through its probablistic risk assessment applicable to a particular repository which it is considering in the licensing context, and has arrived at a reasonably judged PRA as a result of this, this PRA will be contested on all sides because the input data are not as precise and not as readily determined as they would like to have it.

The litigation in this respect is going to be substantially greater than the litigation that has occurred with respect to PRA in the past and the questioning of PRA in its applications here is going to be substantially greater. I don't see how the Commission can adopt a course which supports the application of PRA to a stronger extent for waste repositories than it has taken for the nuclear reactor field.

This comes to the core of my argument at this point. I think PRA has its legitimate place in the determination of safety of a repository and the adequacy of the repository. But I think that PRA in this particular case will have to be considered again as one element in a matrix of matters which the

Commission will have to consider as a basis for the safety of repositories in the future and that this is the appropriate time to raise this with EPA as the basis for joint regulations to be issued by the Commission and EPA in the future to cover acceptability of repositories.

I come out then not disagreeing with the basic objective of what the staff has come forward and proposed to you today. That is to go back and consider further with EPA the changes which now have to be introduced. But I feel that this particular aspect of it has to be introduced at this time so it is clear from the beginning that the Commission is not relying on PRA alone in this final judgment.

That is my point.

CHAIRMAN CARR: Thank you, sir.

Any questions? Commissioner Rogers.

COMMISSIONER ROGERS: What's your view on the orthogonality model that was brought up here a little bit earlier of these qualitative or other considerations? You've mentioned that we look at a number of factors when we evaluate the safety of nuclear power plants, PRA being just one, other quantitative measures of various kinds and other qualitative measures.

Do you have any particular thoughts on how this way of looking at a system and putting it into some kind of a hyper space of orthogonal axes that have different labels on them, whether that makes any sense as a way of conceptualizing a decision?

DOCTOR KOUTS: No, Commissioner Rogers. I think I'm as troubled by such a set of terms as you are. I don't see the term "orthogonality" being applicable here. Supplementary, yes or complimentary, yes, but not orthogonality. Orthogonality, as it's borrowed from physics, means that they have no relationship whatsoever with each other.

COMMISSIONER ROGERS: Independent, truly independent.

DOCTOR KOUTS: Yes. Now, they are not truly independent. They do have overlap. For instance, the event trees in probablistic risk assessment are based on deterministic understanding of the safety situation. They are, however, complementary ways of deriving information from the deterministic views that we have.

COMMISSIONER ROGERS: Well, just -- it seems to me that there is some utility in thinking about things in this way, but one has to be careful.

DOCTOR KOUTS: One has to be careful.

COMMISSIONER ROGERS: They're not independent.

DOCTOR KOUTS: The image is not quite right.

COMMISSIONER ROGERS: Right.

CHAIRMAN CARR: Any other questions?

Commissioner Curtiss?

COMMISSIONER CURTISS: No questions. Thank you.

CHAIRMAN CARR: Thanks very much, Doctor Kouts.

DOCTOR KOUTS: You're welcome.

CHAIRMAN CARR: Any questions?

Well, the staff is to be commended for its rigorous reevaluation of its views on implementation of probablistic standards in the licensing of a high-level waste repository. The complex geologic processes involved and the need to project the long-term performance of the natural and manmade components of a repository make this a challenge unprecedented in engineering and risk assessment practice.

I'd like to give our special thanks to Doctor Kouts for taking the time from his other responsibilities to share with the Commission his views based on his years of experience and the application of probablistic techniques.

I understand that the ACNW will meet in the near future to discuss these issues and will provide comments to the Commission. After receipt of these comments, I urge my fellow Commissioners to carefully consider the information before us in formulating a vote on the staff's recommendation.

I'm sure -- Mr. Egan, we're happy you're with us today and I'm sure you've got complete ideas now on how to rewrite this thing. If it's as clear in your mind as it is in mine, you should have no trouble at all.

Unless there's some additional questions or comments, we stand adjourned.

(Whereupon, at 10:50 a.m., the above-entitled matter was adjourned.)

CERTIFICATE OF TRANSCRIBER

This is to certify that the attached events of a meeting of the United States Nuclear Regulatory Commission entitled:

TITLE OF MEETING: BRIEFING ON IMPLEMENTATION OF THE U.S. ENVIRONMENTAL PROTECTION AGENCY'S HIGH-LEVEL WASTE DISPOSAL STANDARDS

PLACE OF MEETING: ROCKVILLE, MARYLAND

DATE OF MEETING: NOVEMBER 21, 1989

were transcribed by me. I further certify that said transcription is accurate and complete, to the best of my ability, and that the transcript is a true and accurate record of the foregoing events.

Carol Lynch

Reporter's name: Peter Lynch

IMPLEMENTATION OF THE EPA HIGH-LEVEL WASTE STANDARDS

November 21, 1989

Robert M. Bernero

Contact: Daniel J. Fehringer
Phone: 492-3429

OUTLINE

- Underlying basis of the HLW standards.
- Regulatory requirements and the role of performance assessment.
- Questioned and favorable features of the standards.
- Sample application of the standards.
- Recommendation.

UNDERLYING BASIS

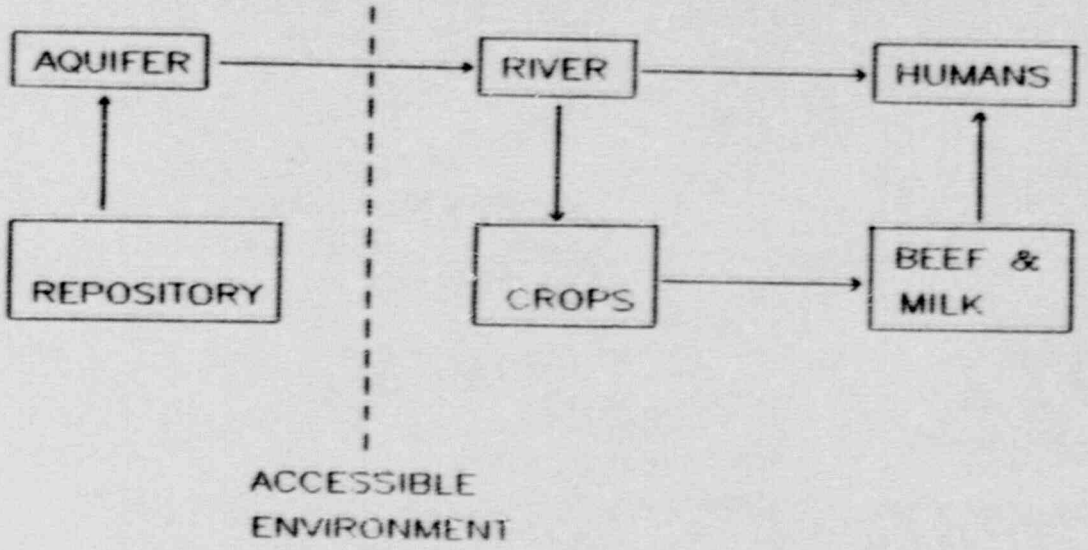
Future generations:

- —will eat as we do
- —will drink as we do
- —will suffer radiation as we do

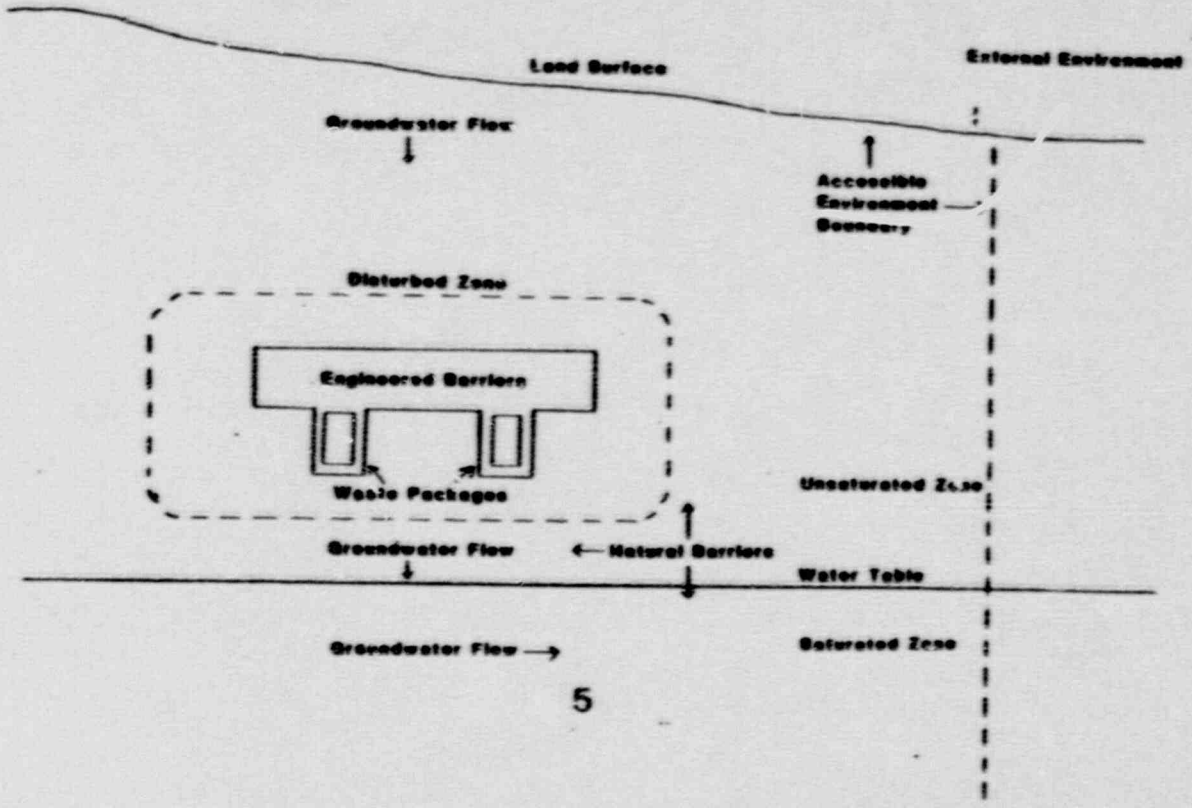
The basis:

Disposal of wastes in a passive repository will ensure that they will not suffer undue risk from our activities.

EVALUATION OF IMPACTS IN HUMAN ENVIRONMENT



SCHEMATIC OF REPOSITORY



REGULATORY REQUIREMENTS

EPA standards for the overall system

Containment Requirement
- —Limits total activity released over 10,000 years
- —Stated probabilistically

Individual Protection Requirement

Groundwater Protection Requirement

REGULATORY REQUIREMENTS
(Cont'd)

NRC requirements for subsystems

Performance objectives
- —Waste package containment
- —Engineered barrier release rate
- —Groundwater travel time

Siting criteria

Design criteria

CONCERNS ABOUT THE STANDARDS

—Standards are unduly restrictive.

—Standards limit releases, not doses.

—Use of probabilities can paralyze the regulatory process.

—Processes are difficult to quantify.
  —Conflicting subjective probabilities.
  —Implied rigor of calculation.

CONCERNS ABOUT THE STANDARDS (Cont'd)

—Mismatches between NRC and EPA criteria.

—Scenario classes and terminology.

—Treatment of human intrusion.

FAVORABLE FEATURES OF STDS

—Emphasis on releases rather than doses simplifies the standards.

—Time cut—off limiting speculation about very long—term phenomena.

—Qualitative considerations language.

—Guidance in Appendix B of the standards — especially on potential human intrusion.

FAVORABLE FEATURES OF STDS (Cont'd)

—Both EPA and NRC regulations are open for revision.

NEED FOR PERFORMANCE ASSESSMENT

—NRC must protect public health.

HOWEVER, to do so there will be:
—No base of operating experience.
—Little opportunity for monitoring.
—Limited use of defense—in—depth designs.

THEREFORE, performance assessment is used:
a quantitative projection of repository performance, including uncertainites.

PERFORMANCE ASSESSMENT is:

—Mathematically modeling physical processes.

—Roughly analogous to containment performance assessment for reactors.

BUT:

—Times and distances are much greater.
—Data base is limited.
—Regulatory role is different.

EPA REQUIREMENT

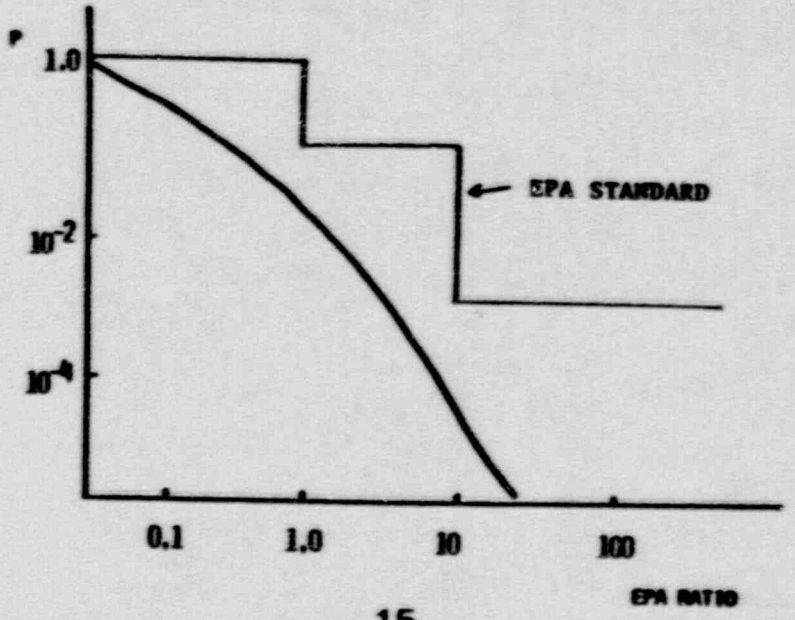
Radionuclide	Release limits (Curies)
C–14 or I–129	100
Tc–99	10,000
Th–230 or 232	10
Any other alpha–emitter	100
Any other beta–emitter	1,000

Probabilistic nature:

–Likely (1.0–0.1) release less than above.

–Unlikely, but considerable (0.1–0.001) release less than 10X the table values.

GRAPHICAL REPRESENTATION



ISSUES FOR LICENSE REVIEW

1. What can go wrong?
2. What are the consequences?
3. How likely is it to happen?

All are technically complex and require projections of future conditions.

#3 is the issue at hand —. Should it be addressed numerically or in a qualitative manner?

EXAMPLE:
HYPOTHETICAL REPOSITORY

Scenario	Estimated probability over 10,000 yr.	Calculated consequence (EPA ratio)
Baseline	0.989–0.9899	0.1
Fault movement	0.01*	1.0
Volcanic event	0.001–0.0001	100

*Conservative, upper-bound estimate

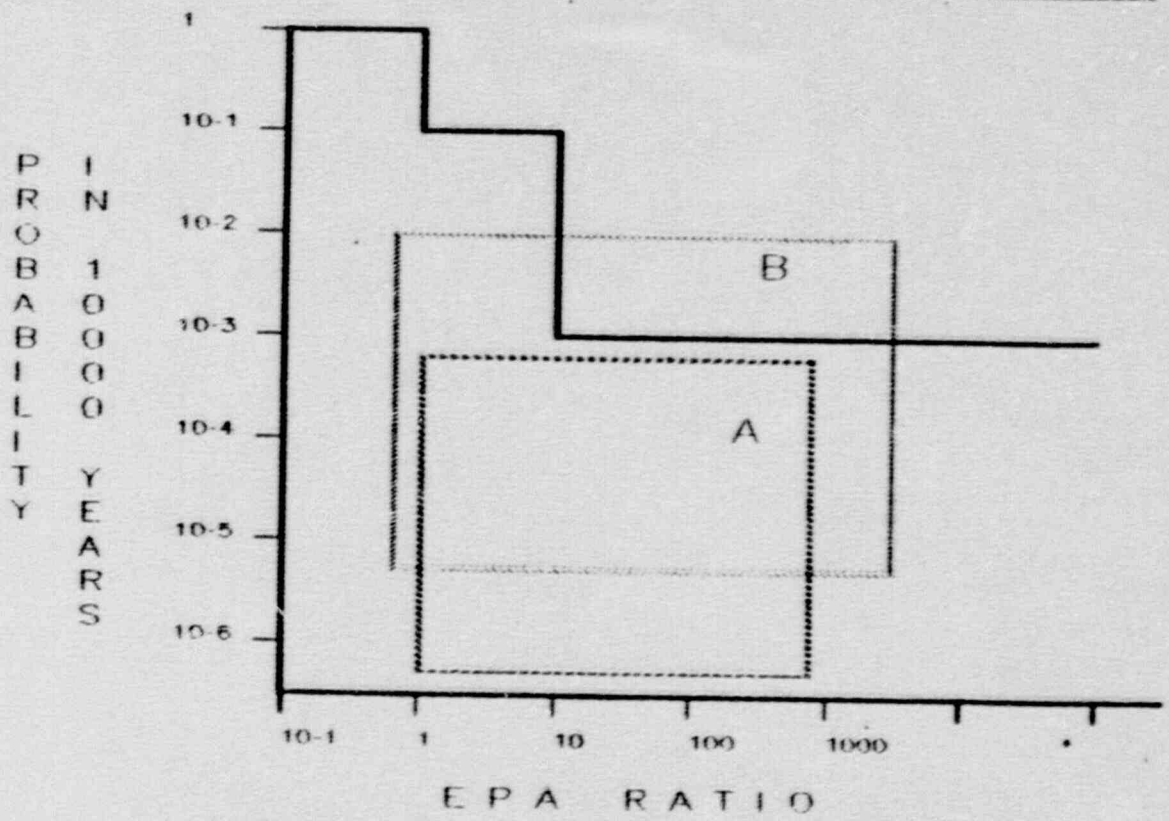
VOLCANISM EXAMPLE

- Model A
  - Cones result from single eruptions.
  - The rate of recent activity is waning.

- Model B
  - Cones result from multiple eruptions.
  - Recent activity is the middle of a cycle.

- Scientific information allows selection of the more reasonable probability estimate.

ALTERNATE CONCEPTUAL MODELS ON VOLCANISM PLOTTED IN CCDF SPACE



A = BEST ESTIMATE FOR CONCEPTUAL MODEL A
B = BEST ESTIMATE FOR CONCEPTUAL MODEL B
------ MODEL A BOUNDS
..... MODEL B BOUNDS

MODEL A
MONOCYCLIC
END OF CYCLE
TOPOGRAPHY HELPS CONTROL
SURFACE STRUCTURE IMPORTANT

MODEL B
POLYCYCLIC
MID CYCLE
TOPOGRAPHY NO EFFECT
SURFACE STRUCTURE NO EFFECT

ALTERNATIVES

1. Current EPA standards and Part 60.

2. Revised EPA standards and current Part 60.

3. Current or revised EPA standards and revised Part 60.

4. No EPA standards and current or revised Part 60.

CONCLUSION AND RECOMMENDATION

—Evaluation of repository safety is inherently difficult because of long times and large uncertainties.

—The EPA standards illuminate those difficulties, but do not cause them.

—Alternative approaches do not appear to be preferable.

CONCLUSION AND RECOMMENDATION (Cont'd)

—The recommendation of SECY—89—319 offers a way to achieve implementability of the standards.

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DATE: 11/28/89

FROM: SECY Correspondence & Records Branch

Attached are copies of a Commission meeting transcript and related meeting document(s). They are being forwarded for entry on the Daily Accession List and placement in the Public Document Room. No other distribution is requested or required.

Meeting Title: Brief on Implementation of the U.S. EPA's HLW Disposal Standards

Meeting Date: 11/21/89 Open X Closed _____

Item Description*:	Copies Advanced to PDR	DCS Copy
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2. Secy-89-319	2	1
3.	—	—
4.	—	—
5.	—	—
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