UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

Title: BRIEFING BY NATIONAL ACADEMY OF SCIENCES (NAS) ON RECOMMENDATIONS FOR TECHNICAL BASES OF YUCCA MOUNTAIN STANDARDS - PUBLIC MEETING

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ANN RILEY & ASSOCIATES, LTD.
1250 I St., N.W.,Suite 300
Washington, D.C. 20005
(202) 842-0034

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BRIEFING BY NATIONAL ACADEMY OF SCIENCES (NAS)

ON RECOMMENDATIONS FOR TECHNICAL BASES OF

YUCCA MOUNTAIN STANDARDS

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PUBLIC MEETING

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Nuclear Regulatory Commission

Commissioners Conference Room

One White Flint North

11555 Rockville Pike

Rockville, Maryland

Tuesday, October 3, 1995

The Commission met in open session, pursuant to notice, at 10:05 a.m., the Honorable Shirley A. Jackson, Chairman of the Commission, presiding.

COMMISSIONERS PRESENT:

SHIRLEY A. JACKSON, Chairman of the Commission

KENNETH C. ROGERS, Commissioner

STAFF AND PRESENTERS SEATED AT THE COMMISSION TABLE:

M. MALSCH, OGC

A. BATES, SECY

R. FRI, Resources for the Future

M. UMAN, National Research Council

P R O C E E D I N G S

[10:05 a.m.]

CHAIRMAN JACKSON: Good morning, ladies and gentlemen. This morning I would like to welcome to the NRC, Mr. Robert Fri, Chairman of the Committee on Technical Bases for Yucca Mountain Standards, and his colleague, Mr. Uman.

This Committee was formed as a result of the Energy Policy Act of 1992 which asked the National Academy of Sciences to advise the Environmental Protection Agency on the technical bases for standards to ensure protection of public health from high-level radioactive waste in a deep geologic repository that might be built at Yucca Mountain in Nevada.

The Committee published its report on August 1st of this year. I should say that I happened to be at Yucca Mountain the day your report came out.

MR. FRI: Yes, we know.

CHAIRMAN JACKSON: The NRC has a great deal of interest in the findings and recommendations of the National Academy Sciences as reported by the Committee. The Energy Policy Act of 1992 directed the Commission to modify its technical requirements and criteria to be consistent with the standards ultimately promulgated by the Environmental Protection Agency which are to be based, as the law stands, on the Academy's findings and recommendations.

The Commission intends to give the Committee's findings and recommendations very careful consideration in subsequent regulatory activities in our high-level waste program and we look forward to your presentation. Commissioner Rogers, do you have anything you wish to add?

COMMISSIONER ROGERS: Not at this time. Thank you.

CHAIRMAN JACKSON: If not, you may proceed.

MR. FRI: Thank you very much. On a logistics note, you have, I think, an outline of just the talking points I am going to use, suitable for making notes and copies are available, I believe, at the doors for the audience.

Let me start by saying that this was a study in which several federal agencies, and most particularly the Nuclear Regulatory Commission, participated in a very substantive way and we had a lot of help from everybody, but we were particularly pleased by the work of the Commission staff, their attentiveness to your problems and the quality of the information they provided us and while we are certainly responsible for the outcome, they provided some terrific input and we appreciate that.

As you have pointed out, this charge came from the Congress as a result of the Energy Policy Act of 1992 in which the Congress asked the National Academy, the National

Research Council, to look at the question of the technical basis for the standards at Yucca Mountain.

They asked three specific questions. To paraphrase somewhat, first, does the standard set in terms of doses to individuals protect the health of the general public; secondly, would institutional controls, active institutional controls, protect the repository from intrusion by humans for a 10,000 year period; and thirdly, is there a scientific basis for predicting whether such an intrusion might occur.

We were asked to answer those three questions, but we were not restricted by the Congress or the Committee just to those questions. We were given a full range to look at whatever parts of the issue we thought were important and we did.

I think it is important to recognize up front that these questions are not idle questions that Congress happened to think of on the spur of the moment, but reflect some controversies surrounding the potential repository at Yucca Mountain.

One of those concerns is the possibility of the release of Carbon-14 during the first several thousand years of the repository closure which might make its way through the mountain to the air and be mixed with the general atmosphere and create a risk that would potentially be under

the existing EPA standard, might squeeze the standard, might, in fact, not meet the standard.

It was certainly the view of Senator Johnston and, I suspect, other members of the Congress, that the costs involved in dealing with this issue were beginning to get out of hand and he wanted a hard look at it.

The other issues on human intrusion, I think, fall into the same category because it is a very tough issue to deal with and creates a lot of uncertainty in the regulatory process and on the whole, I think the Congress felt, both that the costs were beginning to grow disproportionate to the benefits, and the time to get this standard out which had been going since 1985 and in preparation for ten years before that, was just getting out of hand, too.

I will try to outline the contents of the report for you. I will do that with two caveats. First of all, what I will do is give you my view of what the report says, but the authority is the report itself and secondly, there are some important technical points in the report, and while Dr. Uman, the project director, can help me out on those, neither of us is a practicing geologist and I am not a technical person at all, so I may have to simply tell you at times that that is what our Committee believed and if you want more information, you can ask the experts on the Committee.

Briefly, what I am going to tell you and the thrust of the overall report is that we endorse a standard based on individual risk as opposed to dose which is what the Congress suggested in the law as the preferred approach for protecting public health, and I am going to tell you that we will offer an approach to dealing with human intrusion that is based on the conclusion that there is no scientific basis for predicting human behavior and, therefore, the intrusion question has to be handled really separately from other aspects of the standard.

Three comments to sort of set the content that I think are important for this study. First of all, we concentrated strictly on the technical basis for the standard itself and, although as I said, we were not constrained in the issues we looked at within that scope, we did not venture into other areas.

We offer no opinion on the suitability of the site, on the quality of program management and lots of other issues that are at least as important in the repository program as the standard itself.

Secondly, we were asked to provide conclusions specific to the proposed repository at Yucca Mountain and we did. That means that what we say about Yucca Mountain may not work elsewhere and what works elsewhere may not be appropriate at Yucca Mountain. So I ask you not to try to

generalize too quickly from our recommendations.

An important point that I will get to in a few moments has to do, for example, with stability of the underlying geologic regime which we believe is around for a very long time at Yucca Mountain but that may or may not be the case, for example, at another site.

This is important because the standard promulgated by EPA is under the law, as you know, designed to be a generally applicable standard and it was indeed promulgated at a time when the problem was to select a site, not to evaluate a specific site.

So many if not all of the differences between what we have suggested and the present standard that EPA has on the books for WIPP, in particular, I think derive from the fact that we are looking at a site specific case rather than doing what EPA tried to do and had to do under the law in the present standard and that was to produce a generally applicable standard.

Finally, I will try very carefully and the report tries carefully to define the line between science and policy. The operational definition of policy in this case means that, simply, we feel that it is a conclusion that needs to be reached through broad public participation in a rulemaking process in order to ensure the credibility of the conclusion, that you can't reach these conclusions on the

basis of science alone.

In the case where we venture off or where we feel a conclusion has to be reached on a policy matter through a rulemaking process, we do not offer a specific recommendation for the outcome of that process. We, in most cases, will try to recommend a scientifically defensible starting point for the rulemaking, but how it comes out is a function of how the rulemaking comes out.

Against all of that background then, let me talk about the recommendations of the report. The first issue that we had to address in order to get at the question of protection of public health, the first question that the Congress asked us to address is what sort of a standard should we have. The Congress directed EPA to set a standard based on doses to individuals.

Now the goal of any standard of this sort, of course, is to place a societally-acceptable limit on incremental or additional health effects and a dose standard would do that, although it is not stated directly in terms of health effects, the relationship between dose and effect, the dose response relationship is pretty well understood and documented in a whole series of BEIR reports and in other ways.

We did, however, suggest that, rather than state the standard in terms of dose, that it be stated directly in

terms of the risk of an additional health effect, one in a million additional cancers per year, for example, in that form, not necessarily that number rather than in terms of dose.

We have basically two reasons for that. One is that a standard stated in terms of risk is more stable if the dose response relationship changes and the dose response relationship as documented in the BEIR reports, for example, has tended to change over time as more and more is understood about it and so setting things in terms of risk, which is the product of dose and response, means the standard wouldn't have to be changed if the dose response relationship changed and this standard is hard enough to set without inviting future changes.

The second reason for doing it and in some ways the more important reason is that a standard stated in terms of risk, we think, is more understandable to people than a standard stated in terms of dose, at least it has a more intuitively understandable sound to it.

For example, to say the risk of one in a million additional cancers per year is, I think, a more accessible formulation than 0.02 milliSieverts per year for most people and 0.02 milliSieverts per year is given the present dose response relationship the same thing as saying one in a million. So we suggested a risk-based standard which is not

very far from a dose standard but we think it works better.

Having elected risk as the basis for proceeding, then the next step in order to get at this first question of protection of public health is to establish what are the elements of this standard and what would it look like if you set it this way.

There are three basic elements that are outlined in the report. First of all, the level of and this is on the next page, the level of protection afforded by the standard stated as the probability of one additional fatal cancers per year. This is a number that would have to be established by rulemaking because it is a societally determined number, the level of protection that people want to have.

Looking at the literature both domestically and internationally and at other standards that have been set for nuclear operations including your own, it appears that a probability on the order of ten to the minus five or ten to the minus six is a good starting place for a rulemaking to determine the level of protection but as I said earlier, that doesn't mean that that is where it comes out and it is only a recommendation to a starting place.

The second element of the standard is to answer the question who is to be protected. We recommend that the standard be applied to a critical group of persons at

highest risk from the releases from the repository with that group being defined by cautious but reasonable assumptions and present knowledge.

Those are not idle words. Those are the words used by the ICRP in describing a critical group and turning those words into practice as you will see in a moment turns out to be tough but that is the best we have been able to find in terms of the standard for defining a critical group.

But a critical group is essentially a small group of people, tens not hundreds, who include the individual at highest risk and the risk calculated for the critical group is the average of the whole group. There is a little more technical stuff in the report.

Finally, the question one has to answer about the elements of the standard is when should it applied and our belief is that the standard should be applied to the critical group at the time the risk to that group is the highest and that could be for this site on the order of 50 to a couple of hundred thousand years out. We will return to that point too in a moment. So we suggested a standard that is based on risk, that is focused on a critical group and that is applied to the people at highest risk at the time the risk is the highest.

We think that this approach makes sense for Yucca Mountain and indeed has some advantages over the current

standard in that it first of all focuses on the people at highest risk who are the people who live near the repository rather than the general population and the nature of the geology at Yucca Mountain is that the principal pathway which is the water pathway to human exposure, the principal pathway essentially is confined in a basin and is highly unlikely that that water pathway would get very far than a couple hundred kilometers if that away from the site.

So there is a very steep risk gradient and the people nearest the repository are the ones who are going to be at highest risk, not somebody who lives in New York. So it is appropriate to the repository in that sense and also the nature of the geology of Yucca Mountain which is a repository as you know that would be placed several hundred meters above the water tables means that given the decay products and due to the calculations we have seen in performance assessments that have been done thus far suggest that it would take a long time, more than ten thousand years, in all likelihood for the highest concentrations of releases from the repository to depart the repository site.

The current EPA standard is limited to a calculation of what happens over the first ten thousand years and we just don't think much is likely to happen over the first ten thousand years at this particular site. It could be different at another site.

Now that is the form of the standard. The next question that one needs to address before finally getting to the questions the Congress asked is can you assess compliance with this standard and this, of course, is something that interests this Commission.

Compliance assessment is done through probabilistic performance assessment which for purposes of this discussion has two principal parts. One is the modeling of the processes that lead to the release of radionuclides from the cask and their transport through the unsaturated zone to the water table and on out through the groundwater to points where human beings can be exposed to it. There are other pathways. There is an air pathway but the water one is the one I will typically use as an example because it is the most important it appears.

So modeling the concentration levels in the plume as the plume departs the repository site is one step and the second step are the pathways by which people may interact with that plume to be exposed to the radioactivity. That entails people drilling wells into the groundwater, drinking the water, eating food irrigated by the groundwater and so on and so forth.

Our conclusions about these two basic elements of the performance assessment are quite different. We believe that there is an adequate scientific basis for modeling

concentrations, the first step, modeling the concentrations, over something like ten to the sixth years.

That is because it is the view of the geologists in our group that the underlying geologic regime at Yucca Mountain is sufficiently stable to model the behavior over this time period. That doesn't mean that the geology is passive, that nothing is happening, that there will be no seismic events or volcanoes or anything but rather that the basic forces that govern the geologic activity, the basic tectonic forces, are going to not change very much over a million years or so.

So models that you develop based on present understanding will give you reasonable answers over a period of that sort.

I should also say that there is obviously an arched eyebrow when one says that you can make these calculations over a million years so let me explain that it is actually a fairly sensible thing to do and simply to make three points.

One is that not everything becomes more uncertain as time develops over long periods of time. For example, if you are trying to calculate what happens in the first ten thousand years the failure rate on the casks becomes a fairly important variable.

If you are looking out over a very long period of

time, the cask will have all failed anyway unless you are willing to spend a huge amount of money on extremely long lived casks and so the uncertainty associated with that parameter may actually decrease rather than increase.

Secondly, some things that are unknown simply are unknown at the outset and they don't get any less known because of the basic geologic phenomenon and the parameters that you put into the models and finally, there are events like seismic events, volcanoes and climate change that can be incorporated probabilistically into a performance assessment over a very long period because you can talk about the frequency with which they occur but if you try to ask the question, will they occur in the first ten thousand years, that gets to be a really hard question to answer, much harder than simply working with the probabilities over a very long period of time.

The most important point though is that what is at work here is not an attempt to project from today out for some hundreds of thousands of years what is going to happen. What the object of the exercise is to characterize the concentrations in the plume at the time those concentrations are the highest and you simply use models to do that. You have to do a little search to find when that time is and then use the models of the geologic behavior to calculate what the concentration distribution in the plume is going to

be. It is not really a time dependent calculation at all.

So although saying that you are going to calculate a phenomenon that may in fact occur a couple of hundred thousand years sounds a little strange at the outset, what we are really saying, I think, is that the actual calculation is not time dependent.

What is important is that the basic geologic behavior on which the models are based isn't going to change for a long time and therefore when you apply the models in a non-time dependent way, that they are still reliable.

That is the concentration part of it. As I say we felt that there was a scientific basis for modeling these concentrations over a period of time which would probably include the time the concentrations are the highest.

We are less sanguine about the exposure scenario, the assumptions that are required to determine whether people intercept this plume and get exposed to the radioactivity because although science can help bound the exposure scenario, people only eat and drink so much and therefore can only acquire so much radioactivity, there are at bottom some assumptions about human behavior that have to be made and there is no scientific basis for predicting human behavior in our view.

But you need to make some statement, you need to have some assumptions about human behavior in order to

define what the critical group is going to be, where are these people going to live, what wells are they going to drill and so on and so forth and that set of assumptions is a set of assumptions that needs to be defined in a rulemaking.

There is no scientific basis for those assumptions and indeed the Committee was of two minds on even a starting place for that rulemaking. The majority of the Committee felt it was best to approach this problem probabilistically and to allow the siting characteristics in effect to influence the probability of where wells were likely to be drilled.

There are some places on this site where people aren't going to farm and you wouldn't drills wells. So we felt or most of us felt that a probabilistic approach would be the appropriate way to proceed and we have in the report an appendix which describes such an approach.

It is kind of an existence proof. We don't present it as being the way to do it but it satisfied us that such a calculation which is not easy is doable. One member of the Committee preferred that a bounding case be used rather than this probabilistic case and you will find that version outlined in another appendix to the report together with a discussion of why that individual believes that his way is better.

Now I want to say at this point is that choosing between these two approaches is really a matter of regulatory philosophy which obviously the members of the Committee don't share the same one obviously.

We do believe, I think, all of us that the basis guidance is to use the words from the ICRP in making these assumptions, that is to use cautious but reasonable assumptions based on present knowledge because otherwise you start making up scenarios in which there is very little relation to anything reasonable and we agree that the decision should be made through an open rulemaking which in my personal view is particularly important on this question of exposure scenarios because it is possible to create an exposure scenario using fairly small changes in assumptions that will make the repository pass or fail almost inevitably and so getting those assumptions out on the table where everybody can see them as through a rulemaking and agreeing on what the most reasonable set of assumptions are seems to me at least to be absolutely essential.

Now with all of that background I can now discuss the question of the answers to the questions that the Congress asked and let me take the first one, does this standard protect the health of the general public.

Well, in one sense the answer is sure it does because by definition we have applied the standard to the

group at highest risk and therefore, it follows that everybody else in the world is at lower risk on an individual risk basis. So if you just stick to an individual risk standard, the answer is yes because everybody's exposure risk is lower than that of the critical group by definition.

However, there can be public concern and indeed there is public concern that large populations could be exposed to these lower risks and therefore a large number of fatalities might result and remember the population around the mountain itself is quite small and that total in some sense is societally unacceptable.

The procedure that we have proposed for performance assessment and the basis of the standard we have proposed we believe would allow the calculation of such cumulative effects to large populations or world global populations or regional populations such as Las Vegas, would allow the calculation of those risks if somebody wants to do it.

The problem is interpreting the risks of this calculation because it is a calculation in which a very low probability of occurrence is multiplied by a very large population and you get a number or an expected value which is not altogether clear what it means.

There are two problems with it. First of all the

calculation requires specifying the exposed population and the time over which the exposure accumulates to get this sort of total number of fatalities over a period of time.

Both of these are essentially arbitrary assumptions and in the case of the time limit variable and potentially very long and there simply is no basis in science that we can see for establishing a priori the number of people that would be exposed and therefore, no basis for setting a population type standard against which to judge whether the total number of people exposed was acceptable or not.

The other problem is that at very low doses or incremental doses over background which is actually what we are talking about here, there is substantial uncertainty in the dose response relationship.

If you look carefully at the BEIR reports as I am sure you have, you will know that the relationships are based on dose levels that are considerably higher than the ones we are talking about here.

Now it is prudent for most purposes to assume a linear relationship all the way back to zero which is where you get these very low risks that are multiplied by very large population numbers.

However, as the BEIR report points out, at these very low doses and dose rates the uncertainties in the dose

response relationship are very large and, in fact, the response to these very low doses may very well include a zero response. There may be a threshold in other words. Nobody knows that there is but it is also something that according to the BEIR report you can't discount.

So there is a lot of uncertainty in this calculation so coming up with a sort of population or cumulative dose standard is a hard thing to do with a sound scientific basis. So we had to address the question therefore in terms of protecting the health of the general public, is there some way of coming up with a sort of reasonably scientifically rigorous statement that could deal with this problem of exposure to people that are farther away from the repository.

We recommended that in order to place a lower bound on this problem that the regulator consider the concept of negligible incremental risk and the notion of negligible incremental dose is an idea that is used in other countries and when I say negligible incremental risk, I am just going to convert it to a risk basis, and that would be an incremental risk below which the health effects are considered negligible and therefore are not used to influence the judgment about compliance of the repository.

We do not recommend a number for this. We recommend this as the most, in our judgment, the most

reasonable way to proceed but there are some numbers in the literature which we cite.

Just to give you a sense of what we are talking about here, if one took the Carbon-14 that was released from the repository, assumed it all got out, all mixed with the global population and do the arithmetic, you get an individual risk level of something like ten to the minus 11 which is several orders of magnitude below where most risk standards are set today. That doesn't mean it is right. It just gives you some sense of what might be negligible.

So we conclude then that the individual risk standard would, in fact, protect persons at the greatest risk as well as the health of the general public provided that policy makers and the public are prepared to accept that very low radiation doses can pose a negligibly small risk. We did not make the Carbon-14 problem go away but we offer this as a way of dealing with this very tough issue.

COMMISSIONER ROGERS: Excuse me, I wonder if I could just ask a question here. I won't ask on everything but on this particular one, did you have any opportunity to explore this with EPA, for example, or anyone else outside of your Committee as to the acceptability of something like the cutoff?

MR. FRI: No. We examined the practice of other countries and the radiation protection community's

recommendations on this issue. This is not a new issue and essentially agreed with the central thrust of what most people do there and that is to use some kind of a negligibility dose or risk level as a cutoff for concern in compliance assessment. We did not talk to EPA or the NRC for that matter about the acceptability of this.

It was clear perhaps I think I should say in our public meetings of which we had a number before we retired to executive session to write the report that this is an issue that is probably best handled in a rulemaking process rather than the kind of judicial process that you all undertake because it involves a clear policy judgment which is probably more easily addressed in a rulemaking rather than in a compliance hearing.

CHAIRMAN JACKSON: We do them both.

MR. FRI: I beg your pardon.

COMMISSIONER ROGERS: We do them both.

MR. FRI: Yes, you get stuck with both. We try to keep the marbles in the right corners though as we go through this report. So that was our conclusion on protection of public health. Let me then move quickly and briefly into the question of human intrusion.

Basically we concluded that human intrusion should not enter into the probabilistic performance assessment because we can't find any scientific basis for predicting

human behavior and therefore it is impossible to predict the probability of intrusion into the repository. Absent that probability distribution, it is really hard to conduct an analysis of human intrusion in a probabilistic performance assessment.

We did, however, recommend the following two steps to deal with the human intrusion issue. First of all that regulators may want to consider both passive and active institutional controls, guards, signs, pyramids, whatever.

We can't prove and I don't think anybody can prove that they are going to work for any particular period of time but they don't seem like a bad idea and we can't see any reason not to use them and if regulators feel that it is important to use them, that would be fine with us.

The other thing we recommended was that there be a separate consequence analysis of an assumed intrusion to test the resiliency of the repository. We can't predict the probability so it is hard to deal with this probabilistically but you would like to know it seemed to us whether an intrusion would substantially degrade the performance of the repository. So we suggested doing a consequence only analysis. Assume a hole is drilled into the repository through a cask down to the groundwater and see what happens.

We recommended that the standard that would be

applied to such a consequence only analysis be the same standard applied to the undisturbed repository performance. Having said that I need also to point out that the effects of these two cases, that is the undisturbed case and this consequence only disturbed case analysis, are separated in time by tens of thousands of years because the highest concentrations are going to occur many tens of thousands of years in the future after the stuff is all released anyway and the intrusion case is of interest in the early years when the cask is still in tact and you are really disrupting the repository.

So although we apply the same standard, there are really two quite different situations and we think it is reasonable to do that.

One last point or a couple of last points that would be of particular interest to you all on the last page we do say a word or two about technology-based standards which were discussed at our meetings.

We believe that the As Low as Reasonably Achievable concept as it is strictly applied should not apply to repository performance. That is not to say that good engineering isn't a great idea.

It is simply to say that it is hard enough to calculate what is going on with this repository and to suggest that you could at the margin kind of do a cost

benefit calculation just seems to us to be essentially impossible.

So we certainly advocate sound engineering that is likely to produce improvements at low cost but any kind of formal analysis at the margin, we think is likely to prove not feasible.

Secondly, we don't think that subsystem standards such as are established in the U.S. NRC regulations at present have much effect on the judgment, really have any effect, on the judgment of whether a repository at Yucca Mountain would meet the standard or not because they are essentially designed around very short term phenomenon and we are talking about something that is going to happen much, much later.

It may very well be that there are reasons for setting subsystem standards all the way from good engineering practice to public confidence kinds of reasons. We do think, however, that they should be set very carefully to ensure that they don't suboptimize the performance of the repository over the longer term.

Finally, Congress requires EPA to issue a rule, set a standard within one year and then the U.S. NRC to modify its regulations within a year after the EPA standards are issued. We take a look at this and although EPA is already beginning to consider our report and I gather it

hopes to get a proposed rule out before a year is up, the rulemakings that we think have to be made are so important and controversial that it would surprise us that this could all be transformed into a final rule within one year. Your job may be a little easier but it would be a stretch, too. So we simply flag for the Congress, don't expect this all to happen in two one-year periods.

On the other hand, we noted that we did not believe that the fact that the rulemaking and the standard setting may take a little longer need delay the site characterization program. If people want to go ahead and characterize the Yucca Mountain site, the extra time here should not delay them.

That is not a terribly brief summary of what is in the report and we would be more than happy to take any questions that you have.

CHAIRMAN JACKSON: Commissioner Rogers, would you like to raise questions?

COMMISSIONER ROGERS: Yes. I have a large number and I don't think we can get at them all today but perhaps we could just start working backwards in time from your last slide since that is one point that I think is important and that is that the subsystem standards should not suboptimize.

I am not sure exactly what your point of view on this is in this sense that one way of interpreting subsystem

standards would be that you would try to optimize each one of those individually and then you think that by having done that, you have the best possible arrangement and that is always false. That is always wrong.

It never turns out that way in a complex system. If you optimize each individual element of a complex system, it is rare that that will optimize the overall system. In fact, it will suboptimize that system. If that is what you mean, that is an interesting point and certainly one with which I would agree.

However, it seemed to me that in your report you also or you may have suggested that subsystem standards should not be controlling, that if an otherwise overall repository design and site and so on and so forth seems to be quite good, the failure of any subsystem to meet a previously established standard should not fail the entire system.

Now those are two different ways of looking at subsystem standards and I wonder if you want to say a little bit more on how you see them.

MR. FRI: Well, I think on the first interpretation of subsystem standards that that to me is pretty clearly what we meant, that if you start writing a bunch of subsystem standards you will probably suboptimize the performance of the total system and particularly in a

case like this where performance of the system you are looking at is so separate in time from typically where the subsystem standards are set so that is certainly a concern.

The second question, however, and I will let Dr. Uman also comment on this if he cares to, seems to suggest that there are two standards. There is a subsystem set of standards and you can fail those and there is a long term overall performance standard and you can fail the first and pass the second and fail.

I think it is fair to say although we didn't address this question in exactly those terms, I think it is fair to say that the Committee wouldn't think too highly of that. We did look at some recommendations made by EPRI, for example, that there be sort of a short-term first whatever it was, thousand years or so, nothing gets out, zero release standard.

Our reaction to that was well, we don't think that that has much to do with the real evaluation of compliance. If for policy reasons, public confidence type reasons, for example, you wanted to set that as a standard, okay, but that is a policy call and we don't think it has much to do with the actual performance of a repository and in this case, very little is going to happen in an undisturbed case in this repository for a few thousand years anyway.

So any short term subsystem standards or short

term release standards are probably or may reinforce public confidence but as a scientific matter don't really carry very much weight. Did you want to add anything?

MR. UMAN: Just that the Committee was careful to keep in mind that its objective was to describe a scientific basis for a standard based on individual risk which would protect public health.

The focus is on protecting public health and if that objective is achieved, then some other things don't matter such as cask failure rate or transit time to the aquifer. If one is not concerned with the ten thousand year limit but with risk when it really occurs, then the transit time to the aquifer may not be consequential.

COMMISSIONER ROGERS: I think that is helpful to have that out on the table because I think that is an important point. This question of human intrusion, it is a very sticky one, of course. To what extent do you see the issue of human intrusion as site related?

One might think that this is really a problem for any kind of geologic repository and that the question of whether a site is suitable or not doesn't have a very close first order connection with the problem of long term guarding against human intrusion. What is your view on that?

MR. FRI: That is exactly our view. We felt that

there were a lot of potential intrusions that could take place, somebody could drill into a cask, bring the material up to the surface, people can be exposed either the driller or the stuff could be suspended and other people could be exposed and that can happen.

But that is not useful information for decision making about a specific site because it can happen at any site. So there is a lot of potentially important considerations about human intrusion which therefore may be interesting in site selection, find a site that has few natural resources around it so people aren't motivated to drill holes into it, for example, but once you have picked a site most of those considerations are no longer useful in providing decision making information to you or to EPA.

That was basically our feeling. We looked at a whole matrix of intrusive events and consequences in a three-by-three matrix and decided the only one that had any evaluative utility in a specific site was an inadvertent intrusion that pierced or disrupted the performance of the repository and the only useful question at which to look was to ask whether an intrusion would so disrupt or whether the repository was resilient to a specific assumed intrusion.

CHAIRMAN JACKSON: So aren't you then defacto effectively arguing two elements of a performance assessment for the repository, one being that is essentially geologic

in a certain sense and relates to concentrations of radionuclides and the other being based on this consequence analysis that you are talking about?

Because what you are essentially saying is one can put in or discuss or decide through some public policy process, rulemaking you keep saying, assign some number to human intrusion but in the end the real variables in terms of performance have to do with what I would say are geologic factors.

MR. FRI: Yes, you do.

CHAIRMAN JACKSON: And coupled to that is your consequence analysis of some particular intrusion.

MR. FRI: The calculation is essentially the same. I mean, you are looking at the propagation of this concentration.

CHAIRMAN JACKSON: That's correct.

MR. FRI: Given this set of geologic factors.

CHAIRMAN JACKSON: That's right.

MR. FRI: The question then is, what is the forcing function that creates the release.

CHAIRMAN JACKSON: That's right.

MR. FRI: For an undisturbed case, that is a probabilistic function having to do with cask failure rates and other engineering designs of the repository. For an intrusion, "P" equals "1." There is no probability

distribution. You either assume it is zero or one and if you assume it is zero, you haven't learned anything at all so you assume it is one and go ahead and do the analysis.

CHAIRMAN JACKSON: So in the end, it seems as if one puts all of what you said together, that consequence analysis which in the end is going to be rooted in the geology is the ultimate performance assessment piece.

MR. FRI: Not necessarily. We didn't do the calculations but it is entirely possible that the two are not additive because the consequence analysis based on some assumed intrusion scenario we recommended would be done in the first few thousand years when basically the casks would not have failed and there wouldn't be much release otherwise from the repository.

So you force a release in effect by this assumed intrusion and see what happens to the repository but nothing else is going on. You just made it easier for the contents of one cask, let's say, to get to the groundwater.

The other assessment is done at a time when we suspect most of the casks have failed and material en mass has sort of migrated into the groundwater and is coming out and that may be a couple of hundred thousand years in the future.

So the fact that these are separated so far in time suggests to us that they are likely to be additive and

we don't know which one governs.

CHAIRMAN JACKSON: I am not arguing additivity. It just seems that it is a time dependent consequence analysis calculation.

MR. FRI: We don't know.

CHAIRMAN JACKSON: In the short term, it is because of some inadvertent intrusion you have a release. In the long term, you have a release because casks have deteriorated. So in the end it is still a consequence calculation. It is a question that it is a time dependent one in terms of what the consequence might be.

MR. UMAN: The difficulty is that you can't predict the intrusion.

CHAIRMAN JACKSON: No, you can't.

MR. UMAN: But you can predict the failure of the casks.

CHAIRMAN JACKSON: No, you can predict it but you have argued that a scenario that should be considered is one where you would consider the result of the bore hole piercing a canister going through to the aquifer and the fact that you argue that such a scenario should be considered and that the estimated risk relative to the undisturbed case shouldn't effectively be any higher de facto says that you are including it or suggesting its inclusion as part of a performance assessment calculation.

MR. FRI: Yes. We are suggesting that both be considered in judging whether the repository is in compliance with the standard, yes, or whether which one is likely to govern we don't know.

I probably misinterpreted your question. I am sure I misinterpreted it because a question that is often raised in effect says but aren't these additive and therefore isn't the real standard one of a disturbed repository and our answer to that one is we doubt it because of the separation in time.

CHAIRMAN JACKSON: No, that is not my question.

MR. FRI: All right.

COMMISSIONER ROGERS: It was really somewhat along these lines that my questioning was going also in that one might view the question of human intrusion as really not an issue for the judgment of whether a site is suitable or not but whether the whole concept of geologic repository is an acceptable one or not.

It would seem to me that this question of human intrusion, how you feel about whether that can disqualify a site or not, is a very important one.

MR. FRI: Yes.

COMMISSIONER ROGERS: Are you saying that it could but it depends on the result of the consequence analysis or that it is really just a separate consideration?

MR. FRI: I think what we are saying is consistent with what you just said. Given a site, all you can really do is ask whether the repository is resilient to an assumed intrusion in terms of the performance of the repository.

But all of these other factors that you don't consider are relevant if you are asking yourself where is the best place for one of these things or whether geologic disposal is a good idea at all. Those are relevant considerations.

Is there going to be malicious intrusion and I am sure somebody could create a perfectly good argument that says that for all of these reasons sub-seabed disposal would be better but we didn't address that.

COMMISSIONER ROGERS: What I am really getting at is whether one can really decouple human intrusion from the decision of whether a particular site, in fact, we are only looking at one site now, is suitable or not suitable.

MR. FRI: In terms of saying something specific about the effects on public health, yes. I think what we suggested is about all you can do. If you raise the question of is human intrusion a fatal flaw for any site including this one, yes, that could very well be an argument against this site but not because of the specific characteristics of this site but because of a more general argument and we did not look at the more general question.

We just looked at given that we are suppose to look at Yucca Mountain, what can you learn about human intrusion that is useful for compliance assessment and what we recommended in the report is all we thought you could learn.

CHAIRMAN JACKSON: I don't want to beat the dead horse here, but let me beat him again.

COMMISSIONER ROGERS: It could use a little beating, I think.

MR. FRI: I think it is really a very important problem.

CHAIRMAN JACKSON: It is. It you look at your intrusion scenario, the one that you posit in your report, you can say what does human intrusion result in, release of radionuclides. What does deterioration over time, as you point out well separated in time, of the engineered systems result in, release of radionuclides.

So then the question becomes what happens then. You had indicated more comfort down the line with knowing what happens once all the barriers but in the end you are still doing a consequence analysis, the consequence of having a release due to deterioration of your engineered systems or the consequence of some inadvertent damage to your engineered systems or deterioration, inadvertent deliberate damage. So in the end it comes to the same point

it seems to me and it relates to Commissioner Rogers' question.

MR. FRI: I don't know whether this is a Humpty Dumpty problem or not but let me tell you what we think the words mean because that may be part of the problem. I think what we would say is in both cases you are doing a risk analysis, an analysis of the risk of an increase in fatal cancers.

In the case of the undisturbed, it is a fully probabilistic risk analysis because the forcing function, the decay of the canisters and the release through the engineered barriers is handled probabilistically. So the risk of the consequences has been fully probabilistic.

In the case of the intrusion analysis, the intrusion is not handled probabilistically but everything else is. All the other models which are operated, it is the same set of probabilistic models. It is just that the forcing function has a probability of one because we don't think there is a probability distribution that goes with it.

So yes, you are analyzing the same thing and you use the word consequence and perhaps we would use the word risk. We were using the word consequence only to differentiate between a probabilistic distribution of events and just assumed an event was going to occur. I have probably further confused matters but I think I would agree

with what you say. We just use risk rather than consequence.

COMMISSIONER ROGERS: I think we could get stuck on this one for all morning if we are not careful. I do think that this question of human intrusion and how it is handled is extremely important and one has to view it, I think, in the broadest contest because it is a problem with any geologic repository.

MR. FRI: Yes.

COMMISSIONER ROGERS: Any. And if one uses it as a show stopper for judging any one particular site, it may very well be that you could apply the same thing to any site and it will stop it.

MR. FRI: Our judgment that you cannot predict human behavior is not a site dependent observation. That's true. That is the observation on which our whole set of conclusions and recommendations regarding human intrusion rests. So in some sense, they are not site dependent.

COMMISSIONER ROGERS: Well, I think we had better move on. Some of the other points that I thought were interesting in your presentation, in your report, really have to do with some other matters. This question of the basis for exposure scenarios.

I think that is obviously kind of a sensitive point with the Committee, I suspect, because when you have a

dissent, a single person dissent, as well articulated as Professor Pigford's is here, one cannot ignore it.

Some of the troubling points that he has raised there that I would like to hear your comments on are more fundamental things such as what the Committee has suggested as an approach is mathematically incorrect. That is something that has to be dealt with. How do you judge that? Do you believe that it is mathematically correct or do you feel that this is a matter of some interpretation?

MR. FRI: You may have to help me here because I haven't gone back and re-read the appendices recently so I forget exactly what Professor Pigford meant in terms of mathematically incorrect.

He did make a couple of statements that I do remember which I believe are just simply erroneous. For example, he seemed to interpret the approach that was outlined in the probabilistic appendix as saying that nobody would live within some 20 miles of the repository site because nobody lives within 20 miles of the repository site today.

That is simply not the way that the calculation is set up. So there was some misinterpretation, I believe. I don't believe it is crucial to the discussion.

COMMISSIONER ROGERS: That is not a mathematically correct question.

MR. FRI: I know and I am not sure. Do you remember what Tom has said is mathematically incorrect?

MR. UMAN: My impression was that the application of probabilistic techniques to human behavior at all.

COMMISSIONER ROGERS: He made the point that there were a number of arbitrary assumptions made in using the probabilistic method.

MR. FRI: Yes. That is not a mathematical question.

COMMISSIONER ROGERS: No.

MR. FRI: To my interpretation, it is a regulatory philosophy issue and it is the same issue that EPA has grappled with in its own regulations where it has tried to distinguish between the theoretical upper bound estimate, that tube, and the high end exposure estimate which are two concepts promulgated in EPA regulations to try to distinguish between a bounding case and a very high exposure but sort of not bounding case.

EPA hasn't sort of operationalized that definition yet but the difficulty in risk analysis has been recognized. The National Academy or the NRC and incidentally I am required when I use the term NRC in this presentation to tell you that it means the National Research Council.

COMMISSIONER ROGERS: The other one, yes.

MR. FRI: The NRC Report on Risk Analysis that was

released now a year or two ago has in it a dissent. There are two committee points of view on precisely this issue and although 14 members of the Committee felt in this case that a probabilistic approach and what you are talking about is really distributing probabilistically where wells are drilled or where people live rather than just assuming that there is going to be somebody drilling a well into the point of highest concentration. That is the fundamental difference of view here that leads one is the bounding case and the other is the probabilistic case.

COMMISSIONER ROGERS: We have grappled with that, too.

MR. FRI: Yes, I know. It is the same issue and there is no terrific answer to it and we just came out 14 to one and it may be that the 14 of us turn out to be wrong.

COMMISSIONER ROGERS: I won't pursue his particular point of view much further. He did make a point though that this seems to be a departure from international practice in terms of using the subsistence farmer as the model.

MR. FRI: Myron and you will help me here, I believe in some of those cases he refers particularly to the Barroclough study.

COMMISSIONER ROGERS: Right.

MR. FRI: Subsequent events in the U.K. have

resulted in the subsistence farmer recommendation not being adopted by Her Majesty's Inspector or something or another. So it turns out that the international practice is not as consistent as I think Tom believed at the time it would be.

COMMISSIONER ROGERS: Not as uniform.

MR. UMAN: And the Committee has attempted here to put flesh on the ICRP recommendations for the critical group. I think that is an important point. It may very well be that the difference between the two is one of convenience and it might be easier to take a bounding case just for simplicity on the assumption that as we discussed many times that over the period of time when the concentrations in the plume are maximum that there is a high probability that people will, in fact, even if you distribute them randomly, there will be some group of people living over the maximum concentrations and then the two methods essentially converge.

MR. FRI: This concentration front doesn't zip by. It is around for a long time.

MR. UMAN: But we couldn't know that without doing the detailed calculations and those are beyond the capabilities of the Committee in terms of its charge and resources. So the Committee attempted to interpret the probabilistic approach and describe how it might be done.

COMMISSIONER ROGERS: I will just ask one more

question and then let the Chairman jump in.

CHAIRMAN JACKSON: The Chairman is happy to let you ask as many questions as you would like.

COMMISSIONER ROGERS: It is this. It seems to me that at least partly your approach to these questions is based on the notion that one will adopt some kind of a styled model of the future in some way.

Either it is a model for human intrusion or possibility a stylized geosphere, in a sense this concept that it is stable for a million years, not stable but that you understand the dynamics of it for a million years, I guess is probably a better way of saying it and that is not a predictive approach in a sense.

It is really taking a point of view and in a sense I suppose you might say that it is predictive but to what extent do you feel that an approach that should be taken here is that one adopts some kind of a scenario and then analyzes that and that that is a reasonable basis for proceeding as distinct from trying to anticipate what the future holds and look at all of the range of possibilities of future behavior of people, of the geosphere, of the biosphere, the population and so on and so forth?

MR. FRI: I think you have to answer that question somewhat differently for the two major parts of performance assessment. I think the exposure scenario part of it is

necessarily stylized; that is, you are going to make some assumptions and you are not predicting anything. That is terribly important.

The words of the ICRP about cautious but reasonable and based on present knowledge are really important there because just take the present knowledge, one which I interpret to mean don't assume something you don't already know so to assume that there is a cure for cancer becomes kind of not fair but to assume that there are places at Yucca Mountain that are vertical or nearly vertical and therefore unlikely to have wells drilled is something that is based on present knowledge.

If you get away from present knowledge even though you are making assumptions, you can start making up scenarios that will do anything you want them to do so you are not predicting at all. You are just trying to take refuge in what you know conservatively applied to come up with stylized assumptions that people will agree are okay for purposes of compliance assessment.

In the case of calculating when the concentration is the highest so that the exposure scenario can be applied to that time. I am not so sure it is a question of stylized scenario as looking for the time at which that concentration is likely to take place and then taking models of the geologic behavior which are not themselves stylized and

running them in order to describe the nature of the plume over the appropriate period of time.

It is not stylized but it is not predictive either. You are not trying to say that in year 200,152 is when this is going to occur. What you are trying to do is to say when it occurs, here is what it will look like over the relevant time period so that I can then apply the exposure scenario.

COMMISSIONER ROGERS: Thank you very much.

CHAIRMAN JACKSON: These are more in the way of comments than of questions per se. You talk about compliance where the greatest risk occurs and there are two elements of risk and the one that you seem to refer to the most has to do with an exposure scenario and therefore it relates to also concentration of radionuclides again.

But there is a toxicity aspect to the risk which is what I was trying to get at when I talked about the two ways that radionuclides, one on a possible shorter term and one on a much longer term, could cause some release of radionuclides to the environment.

So you talk about wanting to focus on compliance where the greatest risk occurs and the reason I advocate what I call this time dependent risk in your words, consequence in my words, approach or that is what seems to be coming out of what you are saying is that on the short

term you might have a potential intrusion from a bore hole and say you get a small release but highly toxic. That is a risk calculation.

MR. FRI: Toxic in the sense of acute toxicity, chemical toxicity, not radioactivity.

CHAIRMAN JACKSON: Well, it is some of what the radioactivity level is going to decay over time. So again I don't understand the human intrusion at a certain level other than what I call the consequence, risk consequence, of human intrusion comes into play. At a certain level you are leaving it out because you are saying that it is a public policy issue, don't put it into a probabilistic performance assessment. Is that correct?

MR. FRI: Is an example of the kind of event you are concerned about that somebody drills into a cask and brings this material to the surface and then the material is inhaled or ingested?

CHAIRMAN JACKSON: Consequence analysis means you have to look at various scenarios as to what would happen if someone drilled into a cask. You have a release, whether the release ends up in the water or it ends up in the air is part of the modeling you would have to do.

Maybe I am trying to pin you down more than you want to be pinned down but it just seems to me that in the end, you have two fundamental elements of the performance

assessment for the repository as I understand them from what you are saying and that is essentially again the geologic aspects that you think you understand, that people can put probabilistic bounds on and then there is a second piece having to do with what are the consequences of a release by whatever mechanism and the consequence again is going to be rooted fundamentally in the geology and that at a certain level, human intrusion is off to the side because all human intrusion does for you is to give you a release.

MR. FRI: I think we believe that you can understand the geologic processes well enough to do calculations of those probabilistically but that doesn't alone determine consequences.

CHAIRMAN JACKSON: That's correct.

MR. FRI: To determine consequences, you then have to get to an exposure scenario which we have been talking about and we have expressed those consequences in risk terms. Now one way of looking at it is that human intrusion can be thought of as a form or as a sort of exposure scenario in some of its manifestations, that is where the material isn't ultimately released or where human exposure doesn't take place by the normal geologic process that you are modeling. That would be the cause where you drilled.

CHAIRMAN JACKSON: New pathway.

MR. FRI: Yes. You create a new pathway by

drilling into the material and bringing it to the top, for example. We looked at all of the possibilities, all of those pathways, in the report and concluded and we believe pretty firmly that the only one that provided information of interest for determining whether a specific sited repository would pass muster or not was the one that we looked at, that is an inadvertent intrusion.

There are eight other intrusion scenarios that we discarded as not providing useful management decision making information in a site specific case. You may disagree with that but I think we did a pretty careful analysis of all the possible scenarios and that is how we came out.

MR. UMAN: It is also true that the Committee concluded that you couldn't protect the driller.

CHAIRMAN JACKSON: I think it comes back to the fundamental issue of to what extent should any probability of human intrusion be a show stopper as opposed to consequence of it or any exposure that might relate to that.

MR. UMAN: Let me try to characterize how the Committee discussed that problem and it obviously is a very difficult one. What the Committee concluded was and recommended was that a single simple intrusion scenario be used for providing information about the resilience of the repository.

The problem is that one can invent an infinite

number of intrusion scenarios and can't place a probability on any one of them so that in some sense it is an informative analysis but I think the Committee would agree with the statement that it is informative and it provides information but it is not the ultimate test of the repository.

The standard is the test of the repository. This provides information about the resilience of the repository. How that information is to be used, the Committee really has no recommendation. It is something that the regulators have to decide but the information that is provided is very limited because it is not a prediction that this is going to happen.

Whereas, in the other case although that is not a prediction either, we have confidence that it is going to happen. We just don't know when or how or anything like that. We know that the casks are going to fail in the long term and present a public health problem. We can't say the same thing with respect to any human intrusion scenario.

So it doesn't necessarily provide information that is useful in a particular site. I think as Mr. Fri said, it is very helpful at some stage of the entire program for distinguishing between sites on some assessment that there is more likely to be a human intrusion here or less likely there but once you select the site, it is very difficult to

know how to use that information. It doesn't help, I know.

CHAIRMAN JACKSON: The issue is what determines resilience, what goes into the resilience calculation.

MR. UMAN: Yes and the Committee says postulate a drilling scenario, an intrusion scenario and then turn on the same equations that you have done before, do exactly the same kind of analysis and you may or may not find that there is any change in the maximum risk. It is perfectly conceivable that delivering the contents of one cask to the groundwater at a particular time has no influence over the maximum risk because it may occur much later in time when all of the casks have leaked.

So in that sense, it may be useful. It may not.

COMMISSIONER ROGERS: As you said you can't protect the driller.

MR. UMAN: That's right, you can't protect the driller.

COMMISSIONER ROGERS: So you have to exclude the drilling team from the consequences.

MR. UMAN: That's right and by inference, material that is left on the surface. The scenario that we settled on was an inadvertent intruder who doesn't know what he has done so he leaves the hole unplugged. If there was an inadvertent intruder and he understood what he had done, he or she, then he might plug the hole and that would be a

different case altogether.

CHAIRMAN JACKSON: Do you have any other questions?

COMMISSIONER ROGERS: No. Thank you

CHAIRMAN JACKSON: Thank you for as they say a frank and fruitful discussion. Commissioner Rogers and I appreciate your taking the time to brief the Commission on this matter. Your findings will contribute to the discussion and should advance the high level waste program for the country a great deal and you can be assured that the staff and we will scrutinize those results and be prepared in accordance with the law to modify our requirements to be consistent with what the law requires and consistency with the EPA standards when they are promulgated. Thank you. The meeting is adjourned.

[Whereupon, at 11:28 a.m., the meeting was adjourned.]

CERTIFICATE

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

TITLE OF MEETING: BRIEFING BY NATIONAL ACADEMY OF SCIENCES (NAS) ON RECOMMENDATIONS FOR TECHNICAL BASES OF YUCCA MOUNTAIN STANDARDS - PUBLIC MEETING

PLACE OF MEETING: Rockville, Maryland

DATE OF MEETING: Tuesday, October 3, 1995

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

Transcriber: Marilynn Estep

Reporter: Marilynn Estep

Congressional Mandate

- Assess Scientific Basis For Yucca Mountain Standard

Congressional Questions

- Does Individual Dose Standard Protect Health?
- Do Institutional Controls Mitigate Human Intrusion?
- Is There A Scientific Basis For Predicting Intrusion?

Basic Approach To The Standard

- A Risk-Based Standard
- To Protect The Persons At Highest Risk
- At The Time The Risk Is The Highest

Elements Of A Risk-Based Standard

- Level Of Protection Established By Rule
- Protect A Critical Group
- Apply Without Time Limit

COMPLIANCE ASSESSMENT

- ADEQUATE SCIENTIFIC BASIS EXISTS FOR MODELING CONCENTRATIONS OF RADIONUCLIDES

- EXPOSURE SCENARIO REQUIRES ASSUMPTIONS ABOUT HUMAN BEHAVIOR

- TWO APPROACHES TO EXPOSURE SCENARIOS
  - ⇒ PROBABILISTIC (MAJORITY VIEW)
  - ⇒ BOUNDING

QUESTION #1: PUBLIC HEALTH

- HIGHEST RISK PERSONS PROTECTED
- INDIVIDUAL, NOT POPULATION, STANDARD PREFERRED
- CONSIDER NEGLIGIBLE INCREMENTAL RISK

QUESTION #2 AND #3: HUMAN INTRUSION

- SHOULD NOT ENTER INTO PROBABILISTIC PERFORMANCE ASSESSMENT
- INSTITUTIONAL CONTROLS USEFUL BUT NOT PREDICTABLE
- CONDUCT CONSEQUENCE ANALYSIS

TECHNOLOGY-BASED STANDARDS

- ALARA SHOULD NOT APPLY
- SUBSYSTEM STANDARDS SHOULD NOT SUBOPTIMIZE

ADMINISTRATIVE ISSUE

- RULE-MAKING WILL TAKE LONGER THAN ONE YEAR
- NEED NOT DELAY SITE CHARACTERIZATION