UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

***

WORKSHOP TO DEVELOP A STANDARD REVIEW PLAN

USNRC

Two White Flint North

Auditorium

11545 Rockville Pike,

Rockville, Maryland

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The workshop commenced, pursuant to notice, at 8:48 a.m.

P R O C E E D I N G S

[8:48 a.m.]

ORLANDO: This is day two of our workshop on standard review plan for decommissioning. Again, for the record, I'm Nick Orlando. I'm the project manager in the Division of Waste Management, who has the lead for putting together the SRP. As I said yesterday, what we were planning on doing today is open the floor up again to discussion of SRP module 15 and 16 if anybody has anything else they'd like to say about that. The agenda also shows some time at 9:30 to discuss any issues that anybody wants to bring up.

If there are no additional comments on SRP module 15 or 16, we'll move on to that, and if there is no interest in discussing any additional items, then, we will move on to the presentations that Bobby and Mark have. I believe you guys put some -- that's your slides out on the front, right? Okay; thank you very much.

Does anybody have anything else they would like to say about module 15 or 16?

[No response.]

ORLANDO: Make it easy on me. Is anybody here today that wasn't here yesterday?

[Show of hands.]

ORLANDO: Okay; do you have anything you'd like to say about module 15 or 16 of the standard review plan? I'm sorry; the meeting is being transcribed, so if you could come up and speak into the microphone, please.

PRICE: My name is Joe Price, and I work for SAIC. My role in life is to do dose analysis, usually for site-specific situations, and so, that's where I'm most interested in getting guidance, which I guess in the versions of the documents that I had hadn't been carried forward, so I guess I would be interested in knowing where the NRC is

going with guidance on site-specific analyses.

ORLANDO: Okay; on the Web right now, module 5, which is the dose modeling module, it's divided into six or five sections, 5-01, 2, 3, 4. 01 and 2 are on the Web now. I hope to have 3 and 4 out relatively soon. One of the things you'll notice, even looking at module 1 and 2 is that it refers to a technical basis document. The staff is still developing that, and we hope to have that out on the Web for review in April. So that's where we are with the dose modeling.

In addition, since you weren't here yesterday, we hope to have a set of probabilistic distributions for RESRAD and D&D Version 2, which will be a probabilistic version, correct, available in the summer of this year. So that's about where we are with dose modeling, okay?

PRICE: Thank you.

ORLANDO: In addition, you may or may not be aware; we had two Federal Register notices that have tables of screening values, one for surfaces, equipment, building walls and things like that, and the other for surface soil.

Okay; anybody? Dave Culberson.

CULBERSON: Dave Culberson; I have a general comment. Do you want to take that now or wait until the next -- SRP as a whole?

ORLANDO: No, I think now is fine.

CULBERSON: Okay; I was talking with a couple of our members this morning, and we had a suggestion that since DG-4006 is now going to be absorbed into the SRP, there are some sections, particularly at the beginning of DG-4006 and at the beginning, lead-in paragraphs to the various sections that have some very useful overarching information about the decommissioning process as a whole; NRC's process on -- the approach; some of the regulatory positions and good discussion that I think, since the SRP will be a single document, it will be useful to have in there for both the licensees as well as the NRC reviewers, and

our suggestion would be that those parts of the 4006 maybe be captured as well as maybe even an individual module at the beginning of the SRP to provide this broad-based, overarching information about the decommissioning process; the approach, some of the philosophy, how you go about modeling, how you go about deriving in a more philosophical sense than the specifics we'll get into in individual sections.

And one thing that we could offer if you had any interest in that is I was talking to John Konig this morning. We'd be willing to get a copy on the electronic version of 4006 if we could and take a crack on that to give you a straw man to go from just to kind of reflect our -- what we believe is the useful information out here and just pass that along to you as a starting point, if we could have a couple of weeks to work on that. And then, Field Cycle Forum has a meeting coming up next month that we would anticipate discussing a combination of 4006 and the SRP. We would like to generate some comments from that meeting that we get to you later. We would also, you know, any additional comments the group may have, we'd like to submit as well, but we would volunteer to do that if that would be of interest.

ORLANDO: You could do that. I can't guarantee that, you know, what eventually ends up in the standard review plan will look anything like that or if we will even go that route, but, I mean, you know, if you feel that there is some valuable information in the front of the DG that you think gives a good overview, sure.

You said that you thought you would try to get that to us within a couple weeks. How far out are we looking?

CULBERSON: John Konig and I were talking about this, and we were going to try to work on it together. End of February?

ORLANDO: That's fine. It could even go a little bit into March, because I won't be back until the first week of March anyway.

CULBERSON: We have a meeting scheduled the second week in

March, and we could expect to generate some additional comments at that that we will formalize and have for you.

ORLANDO: The additional comments on the DG?

CULBERSON: No, the 4000, the SRP.

ORLANDO: The SRP? Okay.

CULBERSON: The standard review plan.

ORLANDO: Please expedite those because --

CULBERSON: We will.

ORLANDO: -- we do have to start working on the --

CULBERSON: We will try to have those in to you by the end of March.

ORLANDO: Okay; we did say yesterday we could, you know, take them through mid-March if -- okay, sure.

Please identify yourself.

MORTON: Henry Morton.

There are a couple of areas of subject matter in DG-4006, for example, the methodology for ALARA analysis and some provisions from NUREG 1505, some survey methodology that was covered in 1505 that was not in the MARSSIM that's in DG-4006.

At this point, how do you anticipate that you would incorporate that kind of material into the standard review plan?

ORLANDO: I'm still trying to think how I'm going to bring the DG into the standard review plan, so I'm really not ready to get into the specifics of that. Originally, what we had planned to do was leave the DG as an appendix, but it may be better to keep certain sections as an appendix and maybe just bring the words up into the SRP. I'm still trying to figure out the best way to do that so -- it depends a lot on the impact of the comments that we got on the DG.

[Pause.]

ORLANDO: Anybody else have any comments or questions on

anything?

[No response.]

ORLANDO: Anybody have any comments or questions about any other broader issues? Any statements they would like to make or anything they would like to say about something other than the standard review plan?

[No response.]

ORLANDO: Okay; Mark or Bobby, whichever one wants to go first.

EID: We have two speakers: Mark and Dick Cordell. Dick Cordell will be coming soon and bringing his slides. I'll be here just to answer comments and questions if you have any.

THAGGARD: Okay; can everybody hear me?

If you look at the original -- yes, we're getting a little feedback here -- if you look at the original agenda, you see that we were going to talk about the treatment of uncertainty first, and Dick Cordell is going to give that presentation, and he's still making copies of his slides, so his presentation will follow mine.

I'm going to talk about some criteria that we've been developing on how to establish conceptual models. We're still getting some feedback here. It must be --

[Pause.]

THAGGARD: Hopefully, this will work; yes, okay.

Okay; anyway, good morning, everybody. My name is Mark Thaggard. I think most of you know me. I'm a senior analyst here in the Division of Waste Management. As we've already talked about yesterday and a little bit this morning, we are in the process of developing a technical basis document, which is going to have a lot of the information on the dose modeling, and we thought that we would cover a couple of components of that technical basis document this morning, in

particular, how we are going to be dealing with the treatment of uncertainty. That's going to be covered in the technical basis document. And also, this issue about establishing conceptual models. That's going to be covered in the technical basis document. There are some other important issues that are going to be covered in there, like how to change land use scenarios; how to change parameters; things like that that are going to be covered in a lot more detail in the technology basis document than what you're going to see in the standard review plan, when it's -- the sections of the standard review plan when they are put up on the Website.

So we thought we would cover a couple of the components of the technical basis document this morning. We are going to have another workshop in June to cover the whole technical basis document.

What I want to talk about this morning is I want to talk about three particular -- three specific -- I want to cover three specific things. I want to first of all define what we're talking about when we say conceptual models; talk a little bit about why we should be interested in this area; then talk mostly about some of the issues that relate -- some of the issues in terms of establishing conceptual models that are covered in the technical basis document.

And then, I want to end with an example of why this is important, and I'm going to use something out of the RESRAD as an example. And I have to apologize at the beginning here that some of this may seem kind of fundamental to some of you. If any of you have a background in groundwater hydrology and things of that nature, you may be very familiar with establishing a conceptual model, and this may seem like somewhat basic to you, but I've reviewed a lot of dose analysis in my time here at the NRC, and I think there seemed to be a fundamental lack of understanding about establishing conceptual models and how important that is in terms of the dose analysis. So, this is one of the

reasons that we pulled it out and are talking about it specifically as a special section in the technical basis document.

But this is my definition of what I mean by conceptual model, and I will say that this is my definition. Other people may have a slightly different definition, but the main thing we're talking about is we're talking about some kind of qualitative description of what we're trying to analyze, and usually, this involves developing some type of illustration of what we're trying to analyze. And there are some things that should be shown in that illustration. We should identify the source of our contamination, where the contaminants are likely to go and where they're going to wind up at the end. That's basically what we are trying to demonstrate in this illustration.

It should also identify the assumptions that we're making. Ultimately, what we're trying to do with developing a conceptual model is we're trying to build something that we can develop mathematical equations, and from those mathematical equations, we could carry out the analysis. So before we develop the mathematical equations, we've got to know what we're trying to analyze, and that's what the conceptual model gives us.

Okay; I took this picture out of the RESRAD users' manual. This is a good example, in my opinion, of a conceptual model. It shows the source of contamination here; how the contaminants can migrate through the environment; the ultimate receptor location, these individuals here. So assuming that this was our site, and this was the picture that we created of our site, how we are going to be analyzing the site, then, we could -- once we've developed this picture here, we could develop the mathematical equations to show how the contaminants are going to move and what concentrations they're going to get, they're going to get; the concentrations that we're going to get at the place where the people can be exposed. That's what we're ultimately trying to

get, and from that, we can do the dose analysis.

But before we can develop those mathematical equations, we've obviously got to have a picture, and most times, we do have a picture, at least in our mind, of what we're trying to analyze, but what we're saying is you need to take it a little bit further than that and actually put that mental picture on paper. And so that's what we've done in this case here.

Now, some of you may be saying, well, why should we even be concerned about this? After all, we're just going to run the RESRAD code. Do we really need to be bothered with all this stuff about conceptual models and all that kind of stuff? Well, first of all, even if you're running the code that has a predefined conceptual model, like the RESRAD code or the D&D code, those codes have their own conceptual models. You need to know what assumptions you're making, what assumptions are being made in that code and whether those assumptions are applicable for your particular site.

And so, what we recommend in the technical basis document is, first of all, that you should develop a conceptual model, and it should be more than just a mental picture. You should actually develop what you're trying to analyze. You should write it down, so that that way, you can identify the assumptions that you're making, and then, you can easily determine whether those assumptions are compatible with the assumptions that are being made in the code that you are running.

Now, obviously, if you are not using a code like RESRAD, and you are actually going through the process of developing your own computer code, where you're developing your own mathematical equations and things of that nature, obviously, you definitely need to have a conceptual model, because you need to know what you are modeling. But the main reason that we are interested in this issue about the development of a conceptual model is because this could be one of the

biggest sources of uncertainty in the analysis. In fact, the uncertainty in establishing the conceptual model can be much bigger than the uncertainty in any of the parameter values that you put into the code, so you may spend a lot of effort gathering information about your parameters, and then, you don't put that much effort into defining your conceptual model.

Well, the conceptual model, the errors in that may overwhelm, just completely mask any errors that you have in terms of the parameter values that you put into the code, and unfortunately, the uncertainty in our conceptual model is very difficult to quantify. And so, this may be a source of uncertainty that you won't even know or you won't have quantified, so, this is why we think this is important, important enough to treat as a separate section in the technical basis document.

Now, we will point out that one of the things that we're not going to recommend in the technical basis document, we are not going to advocate that people try to quantify the uncertainty in their models. We recognize that this is a big source of uncertainty in the analysis, but we're not going to advocate to people that they have to try to quantify this. That's not something that we are advocating.

Now, if you were to -- most of you are familiar with NUREG 1549, where we've laid out the framework for doing the dose analysis. I've just taken a piece of it here. Establishing the conceptual model would be step three of that framework, so after you've collected your data for your site, and you've established your scenarios, then, you would establish your conceptual model if you are following a decision framework.

Okay; now -- I've got to back up here -- I've got a little bit of problem with my computer here.

[Pause.]

THAGGARD: At any rate, we missed a page. I think most of you have those handouts. Basically, that page I skipped over, I'm going to be covering three main issues that we've attempted to address in the technical basis document in terms of the conceptual model, and those issues are what should be included in the conceptual model; how should we address the multiple conceptual models; and how we should use computer codes that have predefined conceptual models. Those are the three issues that I'm going to cover.

And we talk about, to some extent, in the technical basis document -- the first one is what should be included in the conceptual model. Well, we started writing up this section of the technical basis document; we realized that there are two primary areas that need to be addressed in establishing your conceptual model. First has to deal with the source term. The second has to deal with the environmental transport. Issues and components of the analysis dealing with the biosphere and the dosimetry, those are usually tied up with the land use scenario, and so, those are treated in a separate part of the technical basis document.

And so, in this part of the technical basis document dealing with conceptual models, we primarily deal with establishing conceptual models related to the source term and environmental transport. The other aspects are dealt with primarily in the land use scenario part of the document. These two areas here, the source term and environmental transport, we expect to be areas where you're going to have the most change from one site to the next.

Okay; we look at the source term. I've listed here some of the components of the source term that should be considered when you're developing your conceptual model for the source term. In the technical basis document, we go into a lot more detail talking about these issues. Let me just point out a couple to talk about here. First of all, let's

look at this component, the release mechanism. It's really important when you're developing the conceptual model for your source term that you think about how the assumptions that you're making about how the radionuclides are going to be released.

I think I mentioned at a workshop a few months back when we were talking about the issue about globalization about the fact that if you've got radionuclides that are tied up in a concrete matrix, for example, you probably want to look at modeling that through some type of diffusion process. Well, before you can think about that, you need to know what assumptions you're making about the release mechanism. Also, you need to think about what assumptions you're going to make about the containment failure. Some sites, there may be buried drums or something like that where you -- obviously, you've got to make some assumptions about how those drums fail, when they fail and things of that nature.

So, these are just some of the components that should be covered in establishing the conceptual model for the source term area. We look at the environmental transport. We're talking about primarily transport through the air, groundwater and surface water. In the technical basis document, we go into pretty good detail about aspects of the air, groundwater and surface water; components of the conceptual model -- I mean, components of those pathways that should be considered in establishing your conceptual model.

Most of the sites that we deal with, we're going to have very limited data, and this is why I said at the beginning that if you have a hydrologic background, you're probably used to establishing conceptual models, because you're used to dealing with limited data, and anytime you have limited data, it may be possible that you can get more than one interpretation of that data, and so, if you -- the issue arrives that if you've got more than one interpretation of the data, which interpretation should be used in the analysis.

And this is a much bigger problem than most of you may realize, because, for example, if you've got data at your site, and you come up with an interpretation of that data to establish your conceptual model, I may look at that same data and come up with a completely different interpretation, and, you know, we both could be correct, I mean, in terms of the data. So, you get down to the question, well, which conceptual model should we use? And sometimes, that can have a big influence on the results, and I'm going to show an example of this a little later when I go through the example using the RESRAD code, but the main issue is that we could have multiple interpretations of the same data, and they could be equally plausible based upon the review of that data.

And what we're recommending in the technical basis document is that if you've got more than -- if there's more than one conceptual model at your site, based on the available data, you should use the most conservative one to do the analysis, the most conservative one that's consistent with the available data. Now, we're not advocating that you automatically go out and start coming up with unrealistic conceptual models, but if you can look at that data and come up with more than one interpretation of that data, you should use the most conservative one to do the analysis. That's what we're advocating, but it needs to be consistent with the data, so we're not asking you to make up something that's not consistent with the data.

Now, I saw a couple of frowns when I said that, but if you think about this from a logical standpoint, if there's more than one interpretation of that data, how can you not use the most conservative? Because that means that there is not a plausible explanation of that data that somebody can reasonably come up with, and so, unless you can convince me that that's not going to happen, then, I would say that you need to use the more conservative one to establish whether you meet the

dose criteria.

Now, again, the main thing we've got to look at here is that we're saying it's consistent with the data. Obviously, if you use that conservative conceptual model, and you don't pass, well, one of the things that you may want to do is you may want to go out and get some more data, because maybe some more data may be able to help you narrow down which conceptual model is appropriate.

Now, one of the other issues that we talk about in the technical basis document, and the reason that we specifically talk about this for decommissioning is because I think a lot of people are going to use codes off the -- you know, codes off the shelf, you know, like RESRAD and D&D and things of that nature, you know. Now, one of the issues that we wrestled with is how can we use codes that have predefined conceptual models? Both D&D and RESRAD deal -- they have their own inherent conceptual model, I mean, in terms of what they are assuming the site looks like.

Well, first of all, the first suggestion we have is don't use these codes with blinders on. This may seem kind of obvious, but I've been at the agency for over 10 years, and believe me, I've seen a lot of people use these codes with blinders on, and a lot of times, people have in their mind what they are attempting to model, but that doesn't -- it doesn't come anywhere close to the assumptions that are in those codes, and so, that's why we advocate that you need to develop a conceptual model at your site to make sure that that conceptual model that you've developed for your particular site is consistent with what's being assumed in the code.

Now, we're saying here that all of the assumptions in the code don't have to match all of the assumptions in your conceptual model. That's not what we're saying, because the key is that you want to make sure that where there are differences, you document those

differences; you know what the differences are and that those differences are not going to lead to underestimation of the dose. That's the key. We're not saying that, you know, all the assumptions have to match up.

Okay; I want to go through a somewhat simpler illustration to kind of point out why we are talking about this conceptual model thing and why it's important. I think most of you are familiar with the RESRAD code, the fact that there are two approaches in there for how you model the groundwater, the contaminants reaching the groundwater. One approach is what they call the mass balance approach. Let me explain this figure here. This is a cross-section. Just assume that this is a cross-section, and this little hole here in the middle is a well. We've got a contaminated zone; an unsaturated zone; and this thing down here at the bottom is our saturated zone.

This little triangle here is our contaminants. Now, what the mass balance approach in the RESRAD assumes is, first of all, that the well is in the center of the area of contamination. The other assumption that it makes is that all of the contaminant that reaches the groundwater reaches the well. Now, some of those contaminant -- I mean, the contaminants can be diluted, but it assumes that all of it reaches the well, okay, so that's the mass balance approach.

The nondispersion approach assumes that the well is at the edge of the -- the downgrading edge of the contamination zone. When we look at this same cross-section here, we've got the contamination zone; the unsaturated zone, and the saturated zone, and this is contamination here. Now, the big difference between these two, in addition to the well location, in the nondispersion approach, not all of the contaminants necessarily reach the well, and so, that's a big assumption. And because of these differences here, you can get big differences in terms of the concentration that you estimate based on

these two approaches here.

So, I would look at these two, and I would say that these are two different conceptual models. Now, the question is, well, which one is right? I mean, if you know that your well is going to be at the downgrading edge of the contamination, well, clearly, this one is the correct one to use. I mean, if there are some physical limitations at your site that will prevent somebody from putting the well in the center of the contamination, you obviously want to use this approach here, because you've got justification for using that.

Let's say you don't know that. I mean, there are no physical limitations to prevent somebody from putting that well in the center of the contamination area. The question is which one of these should you be using? Now, the default is the nondispersion. So, if you went in there and used that code without specifying, it's going to automatically use this one down here at the bottom.

I went through and made a little plot here showing how the -- showing the dilution factor that you get using the mass balance and the nondispersion approaches. Now, this dilution factor here is the -- is a factor that -- the concentration that reaches the groundwater is multiplied by this dilution factor. So this accounts for the dilution that you get in contaminants reaching the groundwater. So, for example, if you get a dilution factor of 0.5, the concentration reaching the groundwater would be multiplied by 0.5. So you cut your concentration in half, basically, what that number represents.

And the dilution factor of one means that you basically have no dilution, because you're multiplying the concentration by one, so you're not getting any dilution. You can see that if you use the mass balance approach, it pretty much -- you get a dilution factor of one when you get to 500 square meters, and this is the area of contamination down here at the bottom. The area of contamination of 500 square meters

gives you a dilution factor of one using the mass balance approach, and this is using all of the defaults in RESRAD, and by the way, I'm not advocating that you do that, but just for illustration purposes, I used all of the defaults.

Now, at that 500 square meter area, where you get a dilution factor of one for the mass balance approach, you get a dilution factor of 0.6 for the nondispersion. So instead of getting no dilution, you get a dilution of roughly 40 percent using the nondispersion, so just simply running that code and not specifying which of those approaches you're going to use for treating the groundwater would reduce your dose, it would reduce your concentration in groundwater by 40 percent.

Now, it turns out that the groundwater is the dominant pathway where you can get quite a reduction in your doses based on just how you select the approach you're using for modeling the groundwater. And so, what we would advocate here under this case here, that if you didn't have any other data to support using one approach versus the other, you should use the mass balance approach, because it's the most conservative.

But as I said, if you've got some site-specific information that will support using the nondispersion approach, then, you should use that approach. But outside of having any other information, the one you would want to use in this case would be the mass balance approach.

Now, assuming that you didn't know -- I mean, you didn't have any site-specific information that would say, well, we should use the nondispersion or the mass balance approach, one way you might be able to get around this, if you know the area of your contamination, then I would advocate -- and this is what we're advocating in the technical basis document -- that if the area of the contamination is greater than this ratio here, which is the ratio of the well pumpage to the infiltration rate, what that gives you is that gives you a measure

of the captured zone of the well.

And so, if the area of contamination is bigger than the capture zone, then, obviously, some of the contaminants would not get into the well, which is what is assumed under the nondispersion approach, so a simple calculation like this might be adequate justification to use the nondispersion approach. But you need to do that, though. I mean, you shouldn't just use the nondispersion approach simply because it's the default, because there may not be any justification for it.

So, anyway, this concludes my presentation. I just tried to walk you through some of the things that we're thinking about in this part of the technical basis document, and I'll answer any questions if any of you have any.

ROBERTS: Rick Roberts, Rocky Mountain Remediation Services.

In your example there, you have already assumed that groundwater is a significant pathway and that you have to assess it. If you move your conceptual model up one level, and you look at the conceptual model for a site where you're looking at all pathways: you're looking at soil ingestion, soil inhalation --

THAGGARD: Yes.

ROBERTS: -- all the different pathways, one thing that is very important in that, I feel is very important, is that what that tells you is your world of pathways that you need to assess. But it kind of gives you a guideline, too, for telling which pathways may be significant or insignificant or may be incomplete, and in this guidance document that you're putting together, could you put in some guidance on things that -- pathways you would consider to be significant where you would probably need to quantitatively assess those, things that are maybe insignificant where you don't need to quantitatively assess those, maybe just discuss those, and guidance on what you would consider to be

incomplete pathways? That way, what could be put together is a more streamlined, quantitative assessment when you start looking at a site.

THAGGARD: Well, I do agree that you could probably streamline the analysis, but I don't know if you can do that a priori. I think you -- I mean, for example, if you -- depending upon your initial conceptualization, it can influence which pathway turns out to be important. Like, for example, just take the example here, where if you use the nondispersion approach, for example, it may reduce your groundwater concentration. That groundwater concentration may mean that the groundwater pathway is not that important.

So, simply, how you initially -- the initial conceptual model you come up with may influence what's important, which pathways are important. So, I think the way we've kind of -- the approach we've kind of taken in the technical basis document is that you really need to just do the best job you can up front, describing all the pathways, I mean, in terms of thinking about how you think those contaminants are going to move at that site.

Now, you may be able to -- later on, during the subsequent analysis, you may be able to screen out unimportant pathways and not really give those much attention, but I think up front, in the initial assessment, you really need to think pretty hard about what you're trying to do.

ROBERTS: Okay; and I'll give you an example which clarifies it in my mind, is if you've got a surface soil site, where you've got to clean up surface soils, and of course, you're going to assess direct ingestion, direct inhalation of those soils as well as you're going to look at external radiation, but a pathway compared to that such as if you're looking at wind dispersion to an adjacent water body, where you have wind dispersed and deposition on the water body, and then, you've got subsequent ingestion of water from that body, I would consider that

to be an insignificant pathway and something that really should not be quantitatively assessed and could be addressed up front as being an insignificant pathway.

And that's the type of thing I'm looking at, is that things where you really expect very little radiation dose that really, up front, you could give a discussion and talk about the insignificance of the pathway and really not have to quantitatively assess it --

THAGGARD: Okay.

ROBERTS: -- because it really will be an insignificant part of the total dose.

THAGGARD: Okay; well, we'll think about that. That may be a valid point.

ROBERTS: Okay; thank you.

THAGGARD: Any other questions?

PRICE: Joe Price again with SAIC.

In providing this example here, you are telling us that the NRC would look favorably on some presentation of physical limitations for justifying, say, location of a well.

THAGGARD: Yes, correct.

PRICE: So, if we had a cap and slurry wall around it, and we could say, well, we're having a minimal amount of water moving through our, say, buried waste, NRC might find that persuasive --

THAGGARD: That is correct.

PRICE: -- to say that the well is not to be located outside that.

THAGGARD: That is correct.

PRICE: Is there any upper or lower cutoff on productivity of this well so that we know how to quantify that?

THAGGARD: You mean where you can eliminate the groundwater pathway altogether?

PRICE: So that you can eliminate the well usage pathway.

THAGGARD: Well, that would be the same thing. Yes, we actually -- I think we are going to get into that a little bit in another section of the technical basis document; in particular, we've got a section that we're developing on establishing land use scenarios, so that will probably be part of the land use scenario discussion, and I don't know what that number is right off the top of my head, to be honest with you, but yes, I think we are going to have something like that in there.

PRICE: Thank you.

THAGGARD: Any other questions?

[No response.]

THAGGARD: Okay; if there are no other questions, then, I guess I will ask my colleague, Dr. Codell. I guess he --

EID: Let's wait just a few minutes. He just went outside.

THAGGARD: Okay; he probably went to get some more copies. Okay; here he comes.

CODELL: Thank you.

[Pause.]

CODELL: I apologize for being late. I managed to jam about four copiers in a row trying to make copies this morning. I hope that isn't like the rest of my presentation.

I'm Dick Codell. I spend most of my time doing performance assessments at eye level. I also have been getting into the decommissioning and other kinds of waste management problems lately. I'd like to talk about the treatment of uncertainty in NRC decommissioning. Uncertainty is inherent in all dose assessments and everything else we do in life. We have to consider it in regulatory decision making. The three kinds of uncertainty: we have model uncertainty and scenario uncertainty, and we just heard a talk from Mark

about the first one.

Most of what I want to talk about is parameter uncertainty, how we deal with -- once we've chosen the conceptual models, what do we do with them? How do we evaluate the models? How do we evaluate the results of the models in terms of the criteria?

We also recognize, in addition to these three sources of uncertainty, we are not going to capture all uncertainty, nor do we have to. Sometimes, we can get by just by being conservative.

The emphasis of the uncertainty analysis really is to identify the important assumptions and parameter values that, unaltered, could change our decision. Sometimes, along with uncertainty, we also employ sensitivity analysis, which is a whole field of endeavor. I don't want to get into it today, but it is a way that we can look at the results and further decide which are the important parameters and how they might affect the overall outcome in terms of our regulatory decision making.

Okay; issues of uncertainty are on the next slide. So, we use deterministic or probabilistic analyses. How do we address uncertainty in models and scenarios? What is an appropriate design criterion for probabilistic analysis, and how do we assign probability distributions for use in our models? I'll cover all of these.

First, the -- I'd like to address the issue of whether we should do probabilistic or deterministic analyses. Now, the agency, in general, has been shifting toward doing more probabilistic analyses. Probabilistic risk assessment has been used for many years in reactors. We've been using it for well over a decade in high level waste management. It's getting down to other areas of regulation a little more slowly, but we are definitely considering it for all other regulations as well.

Now, the arguments would be that a deterministic analysis

has the advantages of being simple to implement and easy to communicate to nontechnical audiences. These are big, positive factors, very important factors. The disadvantages are that it doesn't allow consideration of combinations of input parameters over wide ranges of their possible values, and it doesn't provide information on the uncertainty or the sensitivity to the parameter values, and in order to make a strong case using deterministic analysis, you almost always have to require pessimistic estimates of model parameters, usually leading to overly conservative evaluations. Later, at the end of my presentation, I have an example I'll go through with a realistic kind of analysis that show these effects.

Next slide, I cover how do we address models and scenarios of uncertainty, and Mark, I think, covered this adequately. We should use conservative scenarios. We should consider alternative conceptual models and use the ones most conservative but consistent with the site data.

The next question, the next issue was what is an appropriate decision criterion? Well, first, I'll cover deterministic analysis. This figure illustrates that we have a model that depends on N different parameters, and we can sample a value of the parameter from each distribution and then calculate a dose distribution. For doing a deterministic analysis, what we would want to do is pick a conservative value of the parameter, of all of the parameters.

However, this isn't always clear, but it is -- you don't know whether a high value or a low value would be conservative, or in some rare cases, it might be in the middle somewhere, so you may not be able to a priori pick the worst -- the most conservative value of the parameter. But let's say we could. We would pick, say, the value that's at the 90th percent or the 10th percent of the dose curve, whether a low value or a high value was more conservative; plug those

into our model, and then, we would get a single result, which would be probably at the extreme tail of the correct distribution, and this would be our result using a deterministic analysis.

This would be okay as long as we -- as long as it meets the criterion. If it doesn't, then, we have to back pedal.

So, the alternative to doing a deterministic analysis, of course, is to do a probabilistic analysis. The next slide illustrates what is involved in a probabilistic or a Monte Carlo analysis, being one of the kinds of probabilistic analyses you can do. You would have your different distributions, which you would represent by various shapes and ranges, and then, you would stochastically or randomly sample from each distribution one time. Then, with those set of values you've picked, you would run those through your code, through your conceptual model, and then, you would get one output. So, you would have an input, which we call a vector, and an output dose. You would repeat this, then, typically hundreds to thousands of times to get an output dose distribution.

Once you have that distribution, the next question is how do you treat it in terms of the regulatory criterion? The regulatory criteria are usually fixed values, such as 25 millirem dose, don't exceed 25 millirem dose. That's a fixed criterion. However, you have a distribution which some of the values of which may exceed that limit. So, you don't want to penalize yourself too severely. So, what do you pick as the metric of that distribution to compare to the criterion?

Well, here, I start talking about what we do. We use the Monte Carlo analysis to generate this distribution, and then, we consider what the metric is of the output dose distribution. We can calculate the -- two possibilities that -- two main possibilities are we look at the -- for each output, we have a dose versus time curve. We can calculate -- we can take the peak from each one of those curves and

then take its mean, or we can take the average of all of the curves together and take the peak of the average. We call that the peak of the mean versus the mean of the peak, and if that's confusing, that's what it was intended to do.

[Laughter.]

CODELL: Let me show a picture here. This is from the example that I will illustrate later in more detail, but this is actual output from that example. What we have here, faintly, this was a run that had 1,000 runs in it, 1,000 Monte Carlo runs in it, each sampling from the input distributions. I show 10 -- the first 10 outputs from this run, and each one of these is this faint, dotted curve. Now, each one of these curves has a peak. That's these dark circles here, and there's 10 of them.

So, if you take the average of all of the peaks for the 1,000 runs, not 10 here but the 1,000, you would get this value, this dotted line here for the value. Now -- and this heavy curve down here is the average of all the 1,000 dose versus time curves, and its peak is considerably lower. It's about here. So, here, we have the comparing the two possible criteria: the mean of the peaks or the peak of the mean for a typical example. That's just for illustration but to make it a little clearer later.

Now, to go a little more in depth into the discussion about the -- which one to choose, first, let's look at the mean of the peak, the peak doses. If we take all of the Monte Carlo results and take their mean, that's that heavy curve on the previous figure. No, I'm sorry; the other way around; the mean of the peak doses. This is the first one. You take the peak dose from each of the 1,000 runs, and you take its mean. The advantage of this is that it's conservative. You saw that the one way of calculating it was higher than the other. It's conservative, and that's always the case. It couldn't be higher. It's

always higher than the other way.

And the regulations, it seems that the consensus of the NRC regulators is that the regulation clearly states that the criterion is the peak dose, and that doesn't say for the average of all; it seems to refer -- the wording in many of the regulations is that it's the peak dose, and that's the peak from each of the Monte Carlo runs, and it's relatively easily understood. This advantage, though, is that it always produces a higher dose when you do it this way, because it allows you to arbitrarily take each one of the runs, superimpose them on each other, and this is maybe a little bit illogical, because if you have two runs, and one gives you a peak at 100 years, and one gives you a peak at 300 years, you're talking about two different people, and it's not the same person getting the dose, so you're artificially raising the dose this way.

The peak of the mean, we take the average of all the dose versus time curves and then take the peak of that dose, has the advantage of being consistent with the proposed regulations for the high level waste repository, 10 CFR 63, which is going to hit the streets any day. It also treats the uncertainty more fairly in terms of risk to a member of the exposed group. That is the main reason we chose it for the high level waste criterion. And it considers only doses that could occur in a person's life span. You're not talking about two different people eventually. It's always the dose at any given time, the mean dose at any given time in the evaluation period. So it's always referring to a single person.

So, those are the two criteria that are under consideration, and word has it that they will probably go with the more conservative one, but I think it's worth bringing it up in a meeting like this if there is anyone who feels differently about that.

Other considerations in picking a criterion for

probabilistic analysis are instead of picking -- I mean, why do we pick the mean? Why don't we pick something more restrictive, like maybe the 90th percentile of the dose distribution that you get from the Monte Carlo analysis? The advantage of that would be you have a high percentile, 90th percentile, gives a higher confidence that the dose limit won't be exceeded, because you know you have a lot of uncertainty in your analysis. You may not be capturing it all, and this makes the public feel better about it.

And also, the high percentile criterion like 90th percentile would guard against risk dilution, which is a term applied to Monte Carlo analyses where you might have overly wide input distributions, because you don't know your values very well, and so, you've picked wide distributions, and this maybe underestimates the risk, but if you pick a high percentile, you're likely to capture the -- anything that might have had risk dilution associated with it. Disadvantages, though, of picking, like, the 90th percentile is that the mean has a basis in risk, but the 90th percentile doesn't necessarily.

And because the dose results from Monte Carlo analysis are generally skewed by a few large values, and therefore, the mean already is a high percentile, and you'll see that in the example I'll cover later, the mean is almost always greater than the 50th percentile for these kinds of distributions.

Okay; now, the next thing I'd like to cover is how we might go about assigning probability distributions for Monte Carlo analyses. Here are a few general guidelines. The distributions generally reflect the degree of belief that the true but unknown value lies within the stated range. That's where we're dealing with in general here. Now, there's another consideration. There's spatial -- for example, values that are -- there is a true difference between the value of a parameter between one side and the next. The reason? Even within different

places within the same site or the value changes with time. This is often grouped into uncertainty, but it isn't uncertainty. It's something else, and I can't get into a lot of details, but just bear in mind there is this problem between the two kinds of uncertainty, but we're generally dealing with the first kinds. We'll try to keep it focused on that.

We should generally avoid overly restricted ranges that reflect unwarranted precision in our data, because generally, our data is pretty poor; sometimes, nonexistent, and we should, by the same token, avoid overly broad ranges that could cause risk dilution. It has a tendency of making wide distributions when you don't know your data very well.

Okay; now, some more of the guidelines: we don't have to sample every variable that goes into the model. We can just select the important ones that need to be sampled. We can often determine this by doing iterative analyses; that is, we'll do a rough first analysis, and then, we'll see which are the variables that tend to stick out prominently. We cannot always do this, and there's a lot of danger involved in doing that, so you must be careful not to discard variables that don't seem to be important, but that may be an inadequacy in your model.

Now, if you -- once you've decided on the list of variables, you would assign distribution to the important variables, depending generally on the quantity of the available data. If you have lots and lots of data, you can take those, and you can just simply plot it up and get an empirical distribution that you can plug right into your model. Here's an example of something like rock bulk density, which is something where there is a lot of data on. You can just put it exactly and get a .pdf. That's rarely the case.

If you have somewhat less data, you might be able to fit it

to a standard distribution; that is, you might say it fits a normal distribution or log normal distribution and then get a distribution to plug into your model that way. If you have some but by no means sufficient data, you can supplement it with other kinds of data; for example, there may be a physical basis for the shape of the distribution that you may be able to attach to some mechanistic model of the data.

Or, you may know the data not too well at your site, but on a regional basis, you would know that the data are distributed a certain way, and you can use that. You can take that data from a regional or a wider area, and you can update it with -- you can take the non-site specific data, and you can update it with a few site data, and this is generally known as Bayes Theorem. Bayesian updating is another word for it. They're not things we can get into in any detail here.

If you have insufficient data, even less data, you may be able to take other data that are not the same data and infer the results. For example, if you know that root uptake data, you may be able to estimate KD, equilibrium coefficient in soil, what you would use in your retardation part of the calculation. This is frequently done. If all you know about your data are a few key pieces of information, and you don't have anything to fall back on, you can -- the best you can do is to pick an unbiased distribution. There are certain statistical theories of data, one of which -- probably the best well-known is the maximum entropy formalism, which says that in order to -- the least-biased estimator of your data is based on a few rules that involves in maximizing the informational entropy.

And this is in a textbook by Milton Hart that's a well-known textbook, and it's based on a guy's work named Shannon, and he called his work informational entropy. For example, here are two examples of what it does. If you only know the range of the data, this is obvious; if you only have two points, the upper and the lower, you would pick a

uniform distribution between those two values. If you knew only the mean and the standard deviation, you would pick the normal, and you can prove this mathematically that these are the least-biased estimators of your input distribution.

Okay; now, the next point in picking distributions and running Monte Carlo codes is to take into account parameter correlations. For example, you have two variables that are used in the result, A and B, and they're obviously correlated, so when you're sampling your Monte Carlo values, you want to make sure that you capture this correlation. You don't want to pick a value of A here and a value of B that's not correlated to it, because you may end up with a bad combination, which won't serve you well. For example, suppose you have -- you know that hydraulic conductivity and hydraulic gradient would be coupled, obviously, because otherwise, you could have a very large or a very small flow, and if you don't take proper account of those correlations, you may end up picking something that's bizarre. So, these are built into Monte Carlo kinds of sampling routines that we use all the time.

And now, I'd like to go through a simple example. This very simple example is of a -- you have a -- this is looking down on a groundwater situation, where you have a release at a point of a quantity M of the radionuclide, and it is transported down gradient in direction of flow, and it spreads out into a plume. It is also retarded and then is consumed at a user's well. The parameters of the system are the quantity M; the velocity of the groundwater U, the thickness of the aquifer, the dispersivities in the X and Y direction; the retardation and the effect of porosity, the seven parameters.

I put -- the absolute values, of course, aren't important, but I just -- so you could follow it better later on if you wanted to, I put the values I used in the table and also equations I used to

calculate the doses on the next page. But like I said, these are not particularly important.

What I wanted to show for this example, and it probably is somewhat more sensitive than a real example, is that you would get different -- very different conclusions from looking -- choosing the different ways of calculating the result and the different criteria. So, this is a rather busy slide that has everything on here that I wanted to show. Let me go over it.

This is a cumulative distribution of the results from 1,000 runs using that Monte Carlo example, and so, it's a plot of the dose on the X axis versus the cumulative probability of being exceeded on the Y axis. Now, what you see here is -- what I'd like to show is that if you chose the mean of the peak doses, you would get a high percentile, in this case, 71st percentile, of the distribution. So, this is somewhat -- takes into account that we want to pick a high percentile for satisfying the intended audience that the site will comply.

Now, if you took the -- if you did only a deterministic analysis, and you chose your parameters of the analysis and just so you could do one calculation, and you chose the 90th percentile worst value of each of the seven distributions, you would end up with a result that is way, way out here on the tail. It's much, much higher than the dose which you would get from the other criteria. The two main ones that we talked about were the peak of the mean dose, which is the smallest dose and the one that's closest to the risk and what we're using in high-level waste regulation. That's way down here. The mean of the peak dose, which is quite a bit higher but is still reflective of all of the distributions of the data versus the deterministic result, which is way out here, so you're penalizing yourself by doing the deterministic analysis.

So, I'd like to conclude. We must take uncertainty into

consideration in all of the regulations. The deterministic analysis is acceptable, but you must demonstrate that it is conservative, and that may be very difficult to do. We must consider alternative conceptual models and justify those choices. Probabilistic analyses are generally less conservative. Distributions of parameters for the Monte Carlo analyses should be chosen carefully and based on as much site data as possible.

And there are several metrics for the criteria for calculated dose that we're considering: mean of the peak dose; peak of the mean dose; and some percentile larger than the median, say, the 90th percentile.

Thank you for your attention. Any questions?

POTTER: Yes; Tom Potter, Radiation protection consultant. I'm intrigued by the peak of the mean doses approach. Do you mean to say peak of the mean doses where mean is over a 70-year period or something like that, a lifetime period?

CODELL: Well, let me put that slide back up, and I'll try to explain it, that it's caused a lot of confusion. Finally, it sinks in eventually. I don't blame you for being confused. This example here, it's a very simple thing to calculate. We have these 1,000 runs, and we just pick an instant in time, say, 500 years, okay, for example. Then, we take, at the 500 year time, we take the average of all of the 1,000 doses from the 1,000 runs, and that's the mean curve. So, it would be at any time over the whole 1,000 year period.

POTTER: And, in other words, the contribution of one realization, say, where you don't have any dose at all up until the year 2000, in which case you have 20,000 millirem, the contribution of that realization is 10 millirem.

CODELL: Zero; well, I mean, the contribution of that would be zero if it's zero.

POTTER: Up until the last year. Then, you have 20,000 millirem in the last year.

CODELL: Yes, but that would be averaged over 1,000. You'd only -- it would only have a weight of one-thousandth for the total.

POTTER: But I'm only talking about the contribution of that one realization. You're looking at the whole integration.

CODELL: Right; well, you see, each realization will have a weight of 1/N, where N is the number of realizations. So, if it does have a very large peak, like this one has a very large peak, but it only has a contribution of one-thousandth, because there are 999 other realizations, so it doesn't affect the result that greatly, so you don't see it reflected here.

EID: Can I just add more to explain this? I guess in the process, you have different realizations, and each realization will calculate the peak dose for within 1,000 years, because in the rule, we say that you should calculate the dose up to 1,000 years. That's the compliance with the decommissioning. In high-level waste, it is 10,000 years. So, for each realization, you calculate the peak dose within 1,000 years.

POTTER: The peak of the means. Well, I may need to talk with you a little bit separately outside, then. It sounds, though, that in this respect, NRC is gravitating a little bit more toward the EPA approach of lifetime risk-based regulation rather than individual year dose regulation, which I think is probably a good thing overall.

CODELL: It is a good thing, but there are a lot of people who favor the other approach because of its conservatism, but even though it's a significant difference, I'm not sure it would make a lot of difference in actual results. Even in this example, which I think is probably more severe than typical, it makes about a factor of four difference. In the high-level waste regulation, as it turns out, it

makes almost no difference.

POTTER: Okay.

EID: I would like to add that also, the decommissioning rule requires to look for the annual peak dose.

POTTER: Yes, I understand that.

EID: Of the mean dose, and that's the difference.

POTTER: Yes.

EID: Between, you know, the high-level waste and the decommissioning. So, in a way, you know, the explanation currently to look at the annual peak dose, so if we deal with the mean dose, this means we are not treating the peak dose.

POTTER: Yes, I understand that -- right, but we're not there with this right now.

CODELL: We were cognizant of the fact that the high-level waste regulation is stated differently. We were trying to make sure that there wasn't a regulatory conflict among the various parts of the NRC waste regulations.

POTTER: Yes; I have considerable experience in probabilistic risk assessment in the reactor area. I spent about 10 years in that back when it was popular and
I --

CODELL: When reactors were popular.

[Laughter.]

POTTER: Both. I have -- and it has its advantages, particularly in a technical setting or a setting of technical people. I wonder -- well, I don't wonder; I have a serious concern that it's going to be a seriously conflicting problem with one of NRC's other initiatives, which is to increase public involvement, because one of the things that you can best do to gunk up any kind of public discussion of things is to drop in a probability distribution.

CODELL: Right.

POTTER: And that's a real problem that I see we're going to have to wrestle with if we're going to pursue this very far in this kind of regulatory setting. You can get an example -- my experience is that the public is very comfortable with binary thinking and particularly binary thinking phase zero, which is radioactive material is bad, and no radioactive material is good. It takes considerable movement on the part of the public to get to the point that some radioactive material may not be so bad, and a lot of radioactive material is bad.

But to extend that to any kind of comprehension of real probabilistic assessment is very problematic. I think it's particularly problematic when we're focusing the probabilistic assessment on one part of the analysis, specifically parameter analysis, and in a sense, I think we're portraying a picture to the public that we have -- that the picture we're presenting here is the whole picture, and it's going to be very difficult to explain to the public that we've left out a whole range of the picture down here that doesn't matter to us, because it's not important from the standpoint of compliance with regulation, but we're focusing on these scenarios that are pretty much conservatively-defined scenarios, but we're really interested in our uncertainty and understanding of uncertainty about those conservative scenarios.

I don't have an answer to that question but if you're really interested in pursuing this, I think we're going to have to have some way to address that qualitatively or pictures or somehow.

CODELL: That's another difference between this proposed regulation and the regulation of high-level waste repositories. There, we explicitly account for range of scenarios and conceptual models wherever we can explicitly in the PRAs.

POTTER: Yes; I don't see anything in this regulation that

prevents that for the decommissioning.

CODELL: Well, I'm not sure -- I think it does.

THAGGARD: Well, there's nothing in the regulation that prevents it. I think we tried to stay away from that, because usually, to try to quantify the uncertainty in scenarios and things of that nature, you get into the need for expert elicitation, and it becomes -- it can get to be really muddled. The parameter -- calculating the uncertainty in the parameters is something that we felt is doable. We're not saying that we -- we're not recognizing the uncertainty in the other components of the analysis, but certainly, we can calculate the uncertainty in the parameter.

And if it was a fairly easy process to do with the scenarios, we would probably be advocating something for the scenarios, too, but in the high-level waste program, where you're only dealing with one repository, it's much easier to bring in experts and get people to agree or disagree on the probability of scenarios and models and things of that nature.

CODELL: Right; it helps to have tens of billions of dollars to dispose of.

THAGGARD: When you're dealing with a decommissioning site, where you may have one licensee, we felt that advocating that they try to quantify the uncertainty in the other aspects of the analysis may be too much of a burden. We're not disagreeing with your assessment, but we're recognizing that there are some differences in the programs, and we're trying to be a little bit pragmatic about it.

POTTER: Well, that's desirable, and I wouldn't discourage that.

There is one other aspect to this, and that is that the distribution data that we have to work with is usually not very suitable to our needs, and I'll give you a case in point. The outcome is I

believe that our uncertainties in our dose assessments are less important and smaller than we commonly think by running these kinds of probabilistic assessments. For example, consider a situation where root uptake is important. We have distributions of root uptake. Generally, those distributions represent half-kg samples or 1 kg samples, things like that. They may come from all over the country. But even if you have them from one site, they're highly variable, and we take those; we calculate the standard deviation on that basis, and that's what we use in our input distribution.

But a person who has a garden doesn't need a half a kg a year. He needs maybe 10 kgs a year. What we're interested in is not the variability in the half-kg samples. We're interested in the variability in the 10-kg lots. That variability is going to be much smaller than the variability in the half-kg samples. Not only that, but I think it's by the central limit theorem, that variability is going to be much closer to normal, normal distribution, than whatever the underlying distribution of the half-kg samples was. We don't do anything about this, and we don't really have much of a way of doing anything about it in the analysis. As a result, what we do is we overstate the variability in our analysis.

CODELL: I think you could take that into account, Tom.

EID: I would like to add two things: that NRC is trying also to help the licensees. They are tending to go to probabilistic analysis, and because we are developing version two code, which is more probabilistic than D&D code, the new one that's coming, and also, we are supporting development of RESRAD probabilistics, so the licensee could use that version when it is ready. So the process, I expect to be not as difficult as we think, although yes, I agree that it takes some time for understanding all of the probabilistic approach.

So, I expect my perception that for the next one or two

years that probabilistic could be routine as running RESRAD, which is deterministic.

EID: The NRC could still deterministic. If they want to come and use deterministic, that's fine, but as Dick showed, when you run deterministic, you are going to the risk of being highly conservative, and the staff will try to review to make sure that you are highly conservative. So, it is, you know, it is the choice of the licensee whether to go to deterministic; still, they go that; they could take that route or to go to probabilistic.

POTTER: Well, I think we will be helped if we keep in mind the fundamental goal here, and I'm speaking now for probably a few dozen sites where there is relatively low concentration of radioactive material. We don't want to make the wrong decision, or we want to make sure that if we make the wrong decision, we make it only rarely, and if we do make a rare wrong decision, we don't want it to be one with big consequences.

I think we have some protection in that regard with the kind of sites we are dealing here that are the most problematic; that is to say, high volumes of material, low concentration, and I think if we keep that in mind and also keep in mind the fact that the NRC has regulated with considerable success, I believe, for the past several decades with minimal use of probabilistic approaches in this regard, I think we can work these problems out.

MORTON: Henry Morton.

If I understood correctly in the inputs, source term is one distribution that you would input that's treated probabilistically. Now, if that's the case, and you pick something like the mean of the peaks and get a reasonably conservative derivation of the DCGL with this approach, and then, in the final status survey process, where we apply statistics to get conservatism or, that is, a high probability of

compliance with that DCGL, on the other end of the problem, when we come to mesh these, it seems to me that we're really compounding the conservatism in the decision of compliance.

EID: I think the answer to this question, to have a fair comparison, if you compare what we do now and what is proposed, what we do now to go to deterministic to derive the DCGL also of the licensees and try to be conservative, and Dick here demonstrated that when you pick the deterministic approach, so, you will be much, much more conservative than selecting the mean of the peaks, and this is the derivation of the DCGL. So, it's both ways you will be compounding these two together when you do the survey. And that's what we are talking about, which approach, deterministic, which is highly conservative, and then compounded also with the conservative approach in the survey or picking the mean of the peaks and then do the survey, because in both ways, you derive the DCGL, and we are now trying to compare which approaches to pick.

MORTON: My only point is that that argues against needing to be overly conservative on both ends, so, recognition that there is conservatism in both parts that compounds itself is the point.

EID: Yes; I think we discussed that before in the previous workshops, and we understand that, and it is one of the areas that there could be some kind of review by the staff to see what kind of compounding of conservatism when you do the survey, but, you know, here in this case, specific example that we are giving about talking about the uncertainty, where actually, now, we are reducing that conservatism when you go and try to be deterministic and to be overly conservative.

MORTON: Yes, relative to deterministic, sure.

EID: Right.

THAGGARD: And that's one of the points I want to add is, actually, that's one of the reasons that the agency is moving more

toward the use of probabilistic analysis is the recognition by the commission that typically, when you do deterministic analysis, they do have to be fairly conservative, and they typically wind up being awfully conservative, and so, the commission is advocating the use of more probabilistic analysis to reduce some of the conservatism. So, the alternative is, like Bobby's saying, just use deterministic analysis and everybody be, you know, way out on the end.

CODELL: When I worked in reactor licensing, I'm aware of the deterministic kinds of calculations, and for those particular calculations, they were very, very conservative. They were out in the very extreme ends of the curve, and that attests to the overall good safety record of the reactors in this country.

EID: But I would like to add, I mean, in certain cases for deterministic, some people, they may come and just use RESRAD default values, and they may say that we are conservative. It does not mean that. What we mean that when you try to pick up the values, the parameters when you do deterministic, they need to be conservative. For example, if you try to look at values that you did not determine for the site, so, we need to go and be conservative by KD values. If you do not determine KD values, and you do not want to go and spend lots of money for determining KD, maybe you need to assume that your soil is sandy soil, which, possibly, if the groundwater pathway is the most sensitive one, could be the most conservative one.

MORTON: I'm certainly not arguing in favor of deterministic. For those cases for which probabilistic approaches are useful, I'm in favor of being able to use it.

With respect to the graphic that's displayed, I'm wondering -- it isn't entirely clear to me what was sampled to produce the various data points; that is, what was varied and what was sampled? Do you have multiple samplings of the distributions at each of the time periods?

CODELL: Let me put this slide back up.

MORTON: Or do you vary the scenarios?

CODELL: There was only this one scenario. We're not looking at different scenarios. Now, there may be a semantics problem here. Some people call scenarios just a different set of parameters.

MORTON: No.

CODELL: If we have one model like that simple case of the discharge in the well, here, we have -- here, we have the input distributions of the seven variables that are in that model. This is just a cartoon, but -- and we have a distribution of each one of the input variables. For a single run, we would pick a random value from this distribution, say this value for this variable; this value for this one; this value for this one and go through them all and then take those seven values; run it through the model and get a dose versus time curve.

Then, we go back, and we repeat this 999 more times, picking random values from each of the distributions.

MORTON: Okay; that helps to clarify it. So, because I think in terms of sampling as the choice of one value of each of those input parameters, and when you feed that to the code, and the code operates over time.

CODELL: The code does operate over time, but we're doing 1,000 calculations. We're doing it 1,000 times.

MORTON: Is it 1,000 samplings?

CODELL: 1,000 samplings of the parameters.

MORTON: In one run?

CODELL: No; 1,000 runs, too, of the code.

MORTON: Okay; how many samplings, then, per run?

CODELL: One sample per run, because there are only seven parameters. We sample the input values of these seven parameters; plug them into the code; run it to reduce a dose versus time; then, go back

and do another sample of the seven values.

MORTON: Okay.

CODELL: And repeat that 1,000 times.

DARMAN: Darman from Nat-Yankee.

I guess I have a couple of questions. One on that slide: you said something about if the variability really is due to spatial differences or something, it's like, say, KD; now, there's a different kind of rock over there than over there or something, and this really isn't the right way to go.

CODELL: No, this is also the right way to go. It's just -- the model becomes much more complicated. I'll give you an example. There is groundwater models that are called stochastic groundwater models, where you -- they're two or three-dimensional models, and instead of picking one value of hydraulic conductivity or the other parameters that applies everywhere, you know that they're going to vary from place to place within the model because of the variability in the soil and the rock. So, these models go through, and they generate random values of the model parameters within a given run, and these values within a given run, say, hydraulic conductivity, vary from place to place, and they're tied together by other rules like correlations, spatial correlations, which you can get from the field using geostatistical techniques.

But these are very complicated kinds of models. What we're talking about here is, in general, sampling a single value to represent the whole body of knowledge about your situation. You can do that. It isn't -- you should recognize that this is a real phenomenon of spatial variability, but you can still come up with a single representative value that, for the purpose of making your calculation, may be good enough. And the other kind, the other approach, is so difficult and esoteric that it isn't employed very often except in Ph.D. dissertations

and a few other cases.

DARMAN: So, I guess -- let me see if I understood that. KD really does vary --

CODELL: Yes.

DARMAN: -- due to spatial differences, but we could figure out what that distribution is or the max of it and the minimum or whatever; plug that into the D&D code --

CODELL: Yes.

DARMAN: -- and it would be okay to run it that way.

CODELL: Yes; I'm not saying it's easy to do. It isn't easy to do. But practically, that's what you would do, and you would hope that you would capture the variability in your sampling of the true variability, but the two things are different. You can, if you did, say, 1,000 runs, you could pick a different value of KD for each run by sampling it randomly, and you would hope that by sampling randomly, you would be capturing the true variability in the spatial variability as well, so that the value you're actually plugging into any given model run is a representative value that captures all of the other kinds of variability.

This is easier said than done, and you can prove this kind of variability mathematically, and there are some cases that you can deal with it; other cases, you -- it really doesn't make any sense to do that, and those are very esoteric issues of spatial variability. For practical reasons, you have to live with generally just picking a single value of KD. Hardly anyone does any different in these kinds of performance assessments. Even in the high-level program, we're stuck with that.

DARMAN: I guess that maybe is my next question: how does all of this relate to that probabilistic overlay or whatever you're talking, whatever you call it for version two of the D&D Code? Because

I think in that, you can put in a range for KD, right?

CODELL: Right; in fact, the D&D Code, as far as I understand it, the version two, does exactly this.

DARMAN: So, you do put in the input distributions and if they're varying over space or whatever.

CODELL: Well, not over space but over the sample distribution.

[Pause.]

CODELL: I'm sorry; it's hard to explain it any better, and it's not a very satisfactory explanation.

THAGGARD: Well, either way, you're putting in -- whether you're sampling it, or you're putting in a single value, it's going to be -- it's not varying spatially in the model.

DARMAN: No, not in the model. What I'm saying, you take 10 samples, one in that corner of the room, one in the center, all over the place in this room, and you get 10 different results for, I don't know, KD.

CODELL: Yes.

DARMAN: And maybe they really are -- you know, they are varying, because there's different rocks in different places, but in this new version, you can take, like, the lowest value we've got and the highest value; somehow plug that in there, and it's going to run through.

CODELL: But it's not going to capture that problem of the value being spatial, spatially varying. Within a given run, one single run, you'll only have one value of KD, for example.

DARMAN: Right.

CODELL: Because that's all the code can accept.

DARMAN: Right.

CODELL: So, the trick is to pick the value, the single

value, that represents, as far as your model is concerned, all of the data that you know about, and that's a very difficult problem, actually.

DARMAN: And not run -- so you're saying not run the probabilistic version.

THAGGARD: Well, you could run the probabilistic version. The question is coming up with a representative value to plug into that code, whether you run it in a Monte Carlo mode, or you run it in a deterministic mode. You've got to come up with a value that's representative of the particular part of the site that you're analyzing. You've got to come up with a representative value.

DARMAN: But if you run it deterministic, you come up with one value; if you run it in the Monte Carlo way, don't you have to input some kind of -- input the range somehow?

THAGGARD: If you run it in a Monte Carlo, you do have to input a range. The range that you would be inputting would be your uncertainty about that representative value that -- that one representative value that you're using in your analysis. Now, what does that represent? That one value should be based on data that you've collected over the site is another issue. But the answer to -- I mean, I think the answer to your question is that you can -- you can run a distribution; I mean, you can simulate a distribution of KD values in D&D. Now, how you determine that distribution, whether you base it on different values you've collected over the site is another issue, because it gets into the issue of how representative those different values are in terms of what you're trying to model.

So, I think this relates to the question you were talking to me about yesterday, and we probably need to maybe talk about this a little bit separately.

CODELL: You would be generally wrong to take the values that you've collected over a site for different values of KD and base

your input distribution to D&D on those values. The problem is what your distribution based on the values you'd be collecting on the site are the spatial distribution of real variations from place to place.

DARMAN: Right.

CODELL: That's not the value that the code is using. The code is using a representative value that somehow captures all of those data but is not those data. It's some sort of an average.

DARMAN: So, if you had one type of rock, and you took 10 samples right at that place or sand or whatever; you came up with a range of KDs from that --

CODELL: Yes.

DARMAN: -- that would be okay to plug into the code.

CODELL: Well, if they all came -- no, no, they wouldn't, no, because that's mixing the two kinds of uncertainty. That's the point I was trying to get at early on. We're talking about our degree of belief in a real but unknown value of the effective KD for the whole site. That's different from the variability in KD from place to place. They're two different things, and so, what we really want are the distribution in our degree of belief of the value, the effective value of KD that the model uses, not the variation in place to place. So, unfortunately, even if you have a lot of data on your site -- well, if you have a lot of data on your site, you don't have to even do a probabilistic analysis. You can do one analysis. But if you're trying to do a probabilistic analysis, that's not what you want. You don't want the variation of all of the data. That's not your input distribution to the model. That's not the right thing.

DARMAN: I guess I'll leave it there. Thanks.

CODELL: It's hard.

MORTON: If I could -- I think I might be able to contribute a little to that. What you want is a KD that would produce the

concentration in the well that you would actually get on your site, one KD that would produce that, because that one KD value is the only thing you can use in your model. That's what he was talking about about the effective KD; that is to say, a KD that -- one KD value that represents the spatial variability on the site. How you get that from your distribution of empirically determined KDs is magical.

CODELL: It can be done; it's just -- if you have the resources to go out and collect lots of data and also run two and three dimensional time dependent models that are very sophisticated, you can do all this, but I'm saying I've never seen that kind of analysis applied to these kinds of sites. They're not even applied to Yucca Mountain in general.

EID: I think you could do a combination of deterministic and probabilistic. If you have some site data, you could establish a distribution which could be much, much narrower if you do not have site data, so this distribution will be more realistic than the other distribution that you use. So, I would say the site-specific data will be useful to establish a narrower distribution.

ROBERTS: Rick Roberts.

It looks like this mean of peak doses methodology is fairly well-known and entrenched in groundwater modeling. I guess my question would be towards other pathways: soil ingestion, soil inhalation, surface water ingestion, things like that. Is the NRC advocating that this mean of peak doses methodology be applied to other pathways as well?

EID: I would like to say that for metabolic and behavior parameters, we adopted more or less the mean values for those, so I think that the licensee could use the mean values, and those are indicated in volumes one and two and three of NUREG 5512, so they would be more or less consistent with the NUREG 5512 volumes one, two and

three for the behavior and metabolic parameters.

For other parameters that are more site-specific or maybe some of them, like soil indicium, for example, in developing the RESRAD code, for example, there will be distributions for those.

THAGGARD: The answer to your question, I think what you are saying is that curve he showed, the dose curve, would be a total dose curve, so each time you run the -- each time you run the Monte Carlo analysis, you're calculating a total dose, so you're getting a dose not only from the groundwater pathway, but it would be the dose that you get from the other pathways, too.

So, the example Dick gave, I think he just isolated on looking at just a single pathway just to make the analysis simple, but in reality, we're looking at the total dose.

EID: So, in other words, he will input other parameters, too, besides these hydrologic parameters. Yes, there will be other variable parameters, too, like, for example, the density of the contaminated zone; the density of the unsaturated zone; the porosity could be the soil indicia; other factors that, you know, the suspension for the mass loading factors. So, those also, they would have distributions.

ROBERTS: Okay; and I may be wrong, but it sounds like you're using different methodologies for soil ingestion, inhalation and other pathways than for groundwater ingestion, or are the methodologies the same?

EID: No, those are input parameters to the code, and when you run the probabilistic code, you will have these distributions for those parameters, and when you try to make the runs, you calculate the dose with these variables. So, you are varying also those input parameters of the code. You are not just only varying hydrologic parameters. There will be a distribution established for other

parameters as well.

ROBERTS: And I think what you're talking about, I think, is the left hand side of that analysis right there, looking at parameter inputs, and I think the mean of the peak doses is actually -- and maybe I have it wrong -- is actually keying on the Y variable on the right. And so, I guess I'm still -- since I believe you're looking at the left-hand side of that figure, I guess I'm looking more towards the right hand side, where we're looking at the doses as the end product, and how does the mean of peak doses, I guess, apply for other pathways with respect to this type of methodology?

CODELL: It's really straightforward. It's not as complicated as you might think. Your total dose is the sum of your groundwater dose, your ingestion, the airborne inhalation dose. These are all calculated with the codes like RESRAD as a function of time, and so, you're adding up all of these doses, and you're really interested in the total of all the pathways. So the same would apply for whether you're talking about just groundwater or for all the pathways.

THAGGARD: Well, I think the easiest example would be to take the RESRAD code, for example. You could run the RESRAD code and do this problem in that each time you run RESRAD, you could sample the parameters, and every time you sample the parameters, you get a dose distribution curve. Now, that's a total dose curve, because it's looking at all the pathways, and if each time you get a dose distribution curve, you could take the peak from that curve, and so, if you're running that 100 or 1,000 times, you're going to wind up with 1,000 results. And all we're saying is you take the mean of those results.

So, the dose that we're talking about is the total dose. It's the dose from all of the pathways. Maybe you got a little bit confused because Dick isolated on just the groundwater pathway in his

example, but that example could have been -- it could have looked at all of the pathways. I mean, he could have done that example using RESRAD, for example, where you get a total dose.

ROBERTS: Okay; so, this does apply to all pathways. Now, is there going to be something that explains how this is applied to all pathways later on, how that's actually going to be performed, some type of guidance?

EID: Yes; we will try to explain that when we talk about the models and codes, and we'll try to put something in this regard to explain it.

ROBERTS: Okay; thank you.

MORTON: A couple of questions to help clarify that.

If I think of RESRAD or D&D as being a collection of deterministic models, and if I select or make the selection that it run models of several pathways; that is, if I think of a model for each pathway, and I select several pathways, I put in one set of values of input parameters, and that collection of models calculates the dose from each pathway, adds it, and gives me the result as a function of time and can pick out --

EID: That is correct.

MORTON: -- the max.

EID: Yes.

THAGGARD: Correct.

MORTON: So, in way of explanation, would we then say is the -- is the conversion of this collection of models in this code set from a deterministic collection to a probabilistic collection done by grafting on or integrating onto the front end a probability selection module for each of the input parameters that you're interested in varying?

CODELL: Precisely.

MORTON: So, in effect, then, what one has is the ability to set up RESRAD or D&D as you ordinarily would in a deterministic model but, in addition to that, enter the range and probability type for those variables that you want to vary.

EID: That is correct.

MORTON: That you want to sample probabilistic. For sensitive parameters, that is correct. And when you do that, then, they'll take a sample from each of those; feed that individual value of that sample parameter into the model for each of the pathways you've selected; and run it as a deterministic model.

CODELL: That's right.

MORTON: So maybe that helps explain it.

EID: Yes.

MORTON: My question otherwise would be is RESRAD and -- are RESRAD and D&D both going to be designed in fundamentally that way? Are the probabilistic version of RESRAD and the probabilistic version of D&D going to be similar in structure?

THAGGARD: In terms of how similar the codes are, I don't know about that, but yes, both of the codes are going to be capable of doing exactly what you said. Actually --

MORTON: Yes; I'm not asking about the models of the individual pathways. I know there are differences in those, but just in the structure of how you would conceive of the probabilistic version working for each of these two.

EID: We are actually currently doing that, and we have jointly in our -- Sandia, our contractor and ANL, they are getting together, and we are discussing this issue and to see how each modeling code will deal with this uncertainty. I cannot guarantee that they are exactly the same, but we are trying to look, and we are now currently testing the beta version of D&D, version two, and also possibly, for the

next month or so, will be testing a beta version of RESRAD probabilistic, and then, we are looking into that.

MORTON: There was that linkage problem between radionuclides in the early version of D&D. Is that going to be resolved in these two versions, that is, the later version of D&D and the version of RESRAD?

EID: Can you say what is that problem in D&D? Can you say that?

MORTON: Yes; that's when you had multiple radionuclides --

EID: Oh, okay.

MORTON: -- it compounded the upper end --

EID: Right.

MORTON: -- it compounded the probability.

EID: Yes; this issue, for sure, is that's one of the major reasons for developing version two. This is going to be resolved as, you'll remember, we talked about anomalies in the dose values for version one, and that's one of the major reasons we went further for developing version two. So, it will be resolved.

CULBERSON: Dave Culberson.

At the risk of showing my ignorance here, I'm not a statistician, and I'm not highly technical, but I wanted to make sure I understand something. Did I understand you correctly that a licensee could elect, using KD as a value, as an example, a licensee could elect to take multiple samples across the site, come up with a mean number for the KD and use that in the models as opposed to using the most conservative of that distribution? Is that --

CODELL: Well, close but not quite. You see, the problem is -- I wish I could draw this somehow -- the problem is that you can take values of a parameter on a site -- suppose you just created a square grid, and everyplace on the grid, you go out, and you collect a soil

sample, and you take it, and you analyze its KD or whatever the parameter is. Maybe I don't need to write -- but you could then -- you then would have a list of data. Let me draw this; okay. So, you have your site here, and you do some sort of an organized sampling procedure, and you go and collect data from all of these points here, and you have a long list of data, of KD.

Now, what you have here is a long list of data, and you can do lots of things with it. You can take its average, and then, you could say I know the average; I know the standard deviation; I know other things about this distribution. I could draw this -- I could make a histogram of this distribution like this, so this is KD, and you have a density function that looks like the distribution. You can do all those things with it.

But taking the mean value and plugging it into the model is not necessarily correct. It might be, but you don't know. What if all of your high values were over here, okay, and all your low values were over here? Would it make sense to take the mean? Well, I don't know. Probably not. What you really have to do is find out what is the single value of KD that you'd plug into your model that would give you the correct result, and that's easier said than done, because you would have to do the very hard model in the first place. You would have to do a two-or-three-dimensional model to find that out. That's the rub.

CULBERSON: So, in that case, what is the licensee's alternative?

CODELL: Well, I don't have the answers to very hard problems like that. I wish I did.

EID: I think currently, what we will do, we will look to the dose values using the mean of the KD values and look at the bounding analysis if you have the higher and the lower side, and we see what kind of variations we have. That's the staff is going to assist the

deterministic approach, although we prefer to have, of course, more conservative values than the mean, but we'll look into the dose values, and we may run probabilistic analysis to assist how far we are from the conservative dose.

THAGGARD: Well, let me correct Bobby on something. Actually, this whole issue is something that we're still working on. I mean, this part of the technical basis document, we have not finished yet, and so, this may be one of these type of issues that, you know, you may have to wait until we get the document out there on the Website to get a full answer to the question.

CULBERSON: Well, from a more practical standpoint, if we have a licensee who is ready to come in with a plan today or tomorrow, what would they use? I mean, do they go to reference books? Do they use a single sample? Do they use a worst-case KD on their site out of a sampling of 10 samples? What, practically speaking --

CODELL: You'd start off doing the most conservative thing you could do and see whether it's acceptable, and then, if it isn't, then, you could refine your analyses. That's what we're talking about iterative performance assessments.

POTTER: Tom Potter.

This is where you have to get creative on your site again. For example, if all of those high values were real high, and you could calculate from that that material up in that range is not going to leave the contaminated zone, you could confine your analysis to the part of that zone where the KDs are low and do an analysis on that basis or something like that. A conservative approach would be use KDs from the lower end to apply to the whole site. There are a variety of ways to kind of narrow in on it.

CODELL: Right; if this is your distribution of the results and low KDs, you might pick something on the low side, so you -- to

start with, and this is, I guess, what -- if you're an experienced analyst, you would start off doing the least you had to, the cheapest thing, first, rather than spending your employer's money on more sophisticated analyses.

Did I see another question there?

PRICE: It's Joe Price with SAIC again.

In 1998 or so, there were two letter reports that accompanied draft reports of NUREG 1549. The lead author's name was Beiler. One was for the residential agriculture, and one was for the building reuse scenarios. They gave surrogate probability distributions for a lot of important parameters. Do you think, if you were going to use surrogate information in a site-specific analysis, would those distributions be what NRC thinks is appropriate, or has that changed?

THAGGARD: Those are the distributions that are going to be in D&D version two, and certainly, the intent is if you didn't change anything in that code, that's what you're actually running. Now, if you're going to do a site-specific analysis, ideally, you would probably want to narrow those distribution ranges with the assumption that you know more about the site -- I mean, know more about the parameter, and so, you've got some justification for narrowing it, but that certainly would be one way -- I mean, one place to start, just look at those distributions. But they're based on national data, so, presumably, at your particular site, distribution should be a lot smaller.

CODELL: In fact, you could use -- you can use the inferences from the regional or national data and a few site-specific data to come up with a more appropriate distribution that you could use on your site.

THAGGARD: Yes; that's where we get into this thing about the Bayesian updating approach and things of that nature.

EID: Also, in developing RESRAD probabilistic, we will have

also a distribution of parameters that you could use when the code is ready.

PRICE: That will be different from what's in those support documents, or will they be the same?

EID: Some of them, they are consistent; others, more updated. There are certain parameters that are more updated, actually, than those letter reports.

CODELL: Are you talking about the ones for --

EID: RESRAD.

CODELL: The ANL?

EID: Yes, the ANL contract.

CODELL: Right.

EID: Also, we have the contract with PNL about hydrologic parameter distribution. That's another source of information that you could use. And we mention that in the SRP, we refer to it.

PRICE: Is that information publicly available now, or will it be in the future?

EID: It is a contract which is about to be completed, and then, it will be, you know, used as -- either as reference to a NUREG, be a reference to it, or some information may be included in the SRB technical basis documents.

THAGGARD: Well, the NUREG, actually, is down at the publisher's now, so it should be published any week now.

POTTER: Do you have the number on that?

THAGGARD: No, unfortunately, I don't.

EID: We'll provide it to you later if you'll give me your card.

DARMAN: On the new version of D&D, going back to this view chart here --

CODELL: Which one is that?

DARMAN: Where you had the mean of the peaks and the peak of the means.

CODELL: Oh, yes, okay.

DARMAN: Which one is that version going to output?

THAGGARD: Well, whichever approach we settle on, that's what it's going to have.

DARMAN: Okay. It's not going to have -- it hasn't been decided yet?

THAGGARD: No, right now, we've got a -- just a beta version of the codes, and the contractor is -- that's one of the inputs that we've still got to get a contractor.

CODELL: Anyone else?

[No response.]

CODELL: Take your best shot.

[Pause.]

ORLANDO: Okay; if that's it, well, thank you, Mark and Bobby and Dick. Does anybody have any more questions on anything?

[No response.]

ORLANDO: The good news is I think it's raining outside, which means it's probably melting all of the stuff that was holding up any airplanes.

Does somebody have a question in the audience?

SPEAKER: Will we hear from Bobby? It sounds like you're wrapping it up.

EID: Well, I think, you know, what we are doing now, still, we are in progress for developing the SRP dose modeling. The technical basis documents, I believe, will be the most important parts of the SRP, because, of course, I am not underestimating the importance of the others, but those, they will be the areas where many licensees, they are not familiar with, and hopefully, we will try to put those together.

Also, we will put those on the Website, hopefully, in April.

Please try to keep your eyes open to read those. They will impact the way you do dose modeling analysis, and they are very important. Please read those when they are on the Web and try to give us your feedback, and we are not, you know, coming to the end right now. We are developing the codes; we are developing the models, assisting the beta versions of both RESRAD and D&D, and we will try to make changes, but we would like to have your feedback, so please, you know, let us know and communicate with us whether through the Internet or through phone calls or even in writing.

We are trying to finalize now, hopefully by June when we have the next workshop, we will have similar workshops like this. It will be a very lively workshop hopefully regarding dose modeling, and then, we will try to make the changes, and hopefully by that time, we will be developing the final SRP in July.

Again, the SRP, although we call it is final in July, it will be a dynamic document that we could change it also, and we will come and make the changes. The codes and models hopefully will be available in the summertime, so by the time the SRP is coming out in July, so hopefully, also, we will have the models and codes, probabilistic models and codes will be available for public use.

THAGGARD: I think there was probably some confusion. I think Nick told everybody that Bobby was going to give a presentation, and the confusion was that actually, Dick was giving the presentation.

ORLANDO: I apologize for that. I thought that Bobby had said that before we got into the presentation.

EID: I want to thank you all again for your feedback, and, you know, hopefully, we will get more information in the future.

ORLANDO: Dave, did you have something you wanted to add?

CULBERSON: Yes. This is Dave Culberson.

Just a final comment. I just want to express appreciation. I think this was a good workshop. All of them have been helpful. We appreciate NRC involving licensees in these discussions. I think there has been a real healthy exchange of information, a lot of information passed back and forth, which is always good for understanding on both sides, and I would encourage continued participation. We are more than willing to do what we can as the Fuel Cycles Facility Forum, and I just applaud your effort to try to make this process clear and painless and helpful to everybody.

ORLANDO: That's our goal, too.

Now, if anybody has any other questions or comments, does anybody have anything to say about any SRP modules?

[No response.]

ORLANDO: Okay; well, then, thank you very much. Everybody be careful going home, and I hope you all make it.

[Whereupon, at 11:05 a.m., the workshop was concluded.]