UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

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DECOMMISSIONING WORKSHOP

U.S. Nuclear Regulatory Commission
Two White Flint, North, Auditorium
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Rockville, MD

Thursday, June 24, 1999

The above-entitled workshop commenced, pursuant to notice, at 8:34 a.m.

P R O C E E D I N G S

[8:34 a.m.]

MR. NICHOLSON: If I could have your attention, please, we'd like to begin today's meeting.

My name is Tom Nicholson. I'm from the Office of Nuclear Regulatory Research, and I will be today's moderator, along with Jack Parrot.

Jack, would you raise your hand, please?

Jack Parrot is from the Office of Nuclear Material Safety and Safeguards.

There's a few announcements before we begin today's program.

First of all, some of you had some troubles getting up and down yesterday from the snack bar.

We found out that the problem was that, if we have more than four people in the elevator, it breaks down, and when the guard was upset, they said that the elevator broke because there was too much weight, I said, well, don't look at me.

So, if you could try to limit the number of people on those elevators to four, we'd appreciate it.

The other quick items -- outside on the registration desk is a sign-up sheet. Would you please sign it, if you didn't sign it yesterday? We need to have a complete record, and last night, we stayed late and we made copies of yesterday's attendance list. So, there's a copy out there.

We're also trying to get copies of all the view-graphs that were presented yesterday. We have some of them, but there's still one or two that we are still making copies, and we hope to have those before the end of today.

With regard to this afternoon, there is an opportunity for those who wish to make extended comments -- there will be a group discussion, but right after lunch, those people interested in making extended comments, please come and see me during the break, or Dr. Ralph Cady, the gentleman who ended yesterday's group discussion, and we'll take down your name and your affiliation, and we'll try to put some order to the presentations this afternoon around 1:30.

Now, to kind of recap yesterday's events and where we stand today, for those who weren't with us yesterday, yesterday we heard a regulatory perspective from Dr. Boby Eid, who has joined us now, and then Mark Thaggard gave us a framework, in keeping with NUREG-1549, and then we went through the conceptual models of the conventional dose assessment codes, RESRAD, DandD, MEPAS, and PRESTO, and then, as we progressed through the discussion of conceptual models, we found a lot more about these various codes, and we also heard about publicly-available information, and then we actually had an example where a researcher actually tried to develop a methodology to try to walk through the development of a conceptual model looking at an actual site and using remote data, and so, today, what we're going to do -- we're going to try to continue this progression through the decommissioning review with regard to ground water, and we're going to hear from two DOE investigations of looking at performance assessment.

This morning, we're going to have Dr. Phil Meyer from Pacific Northwest National Laboratory progress beyond what Glendon Gee talked about yesterday.

If you have now looked at the publicly-available information, how do you then begin to look at site-specific parameter estimation techniques?

So, Phil will talk about that.

Phil?

MR. MEYER: Tom, as you pointed out, I am going to try to kind of continue in a logical progression from some of the discussion that was held yesterday, and I am going to be talking about estimating model parameter values but in specific with the consideration of the uncertainty of those parameters and estimating uncertainty in those parameters.

I just want to point out an assumption here at the beginning of my talk that I'm assuming in this analysis that I'm going to be presenting that there's no site-specific measurements of contaminant concentrations.

So, that means that the option of doing some sort of an inverse procedure with one of these codes is not an option. It's not something that I'm going to consider here.

If measurements of contaminant concentrations are available where you can do some sort of formal inverse estimation or parameter estimation using that, those measurements, then by all means I think that sort of approach should be taken.

Glendon presented this picture yesterday, and generally, it shows a broad classification of types of information and application of that information in terms of increasing site specificity and reduced uncertainty, and I'm not going to say too much more about that. This sort of organizes my talk.

I'm going to just summarize what was on that sheet as follows.

Essentially, there are two types of information -- site-specific information, which I take to be direct on-site measurement of properties that are directly related to model parameters.

The other type of information is everything else, is everything that's not site-specific direct measurements of parameter-related things.

We can put these two types of information to two types of uses, basically. We're interested in best estimates for parameter values, and we're also interested in uncertainty information.

Now, that uncertainty information can be characterized in various ways, like bounding values, conservative values, formal probability distributions, or just general qualitative information about an uncertainty in a parameter.

So, I'm going to spend a few minutes talking about why parameter uncertainty might be considered important. Perhaps this is all self-obvious, but I think it's useful to point it out.

Number one, hydrologic properties may be highly variable, though in a spatial sense or a temporal sense, a parameter value related to some property may vary over many orders of magnitude.

This is a log of the hydraulic conductivity, and it represents maybe an average sort of a variability you might see at a site, varying over several orders of magnitude.

So, that high variability leads to -- can potentially lead to uncertainty in that parameter value.

In addition, the parameter values can be based on inaccurate date or incomplete data or just limited data. For instance, if this represents the spatial variability f the hydraulic conductivity at that site and we have three data points that we went out and took maybe small core samples on or some larger sampling, you have to try to characterize the spatial variability at the site or the average value of that spatial variability with three measurements.

You could be in trouble, depending upon what those measurements are and how variable the parameter that you're interested in is.

In addition to those two quantities, variability and limited information, we also realize that these -- the models that we're going to be using are quite sensitive to parameter values, and this is just a case from an example using RESRAD, but you know, any of the other models we've been talking about, or any model, in fact, would show similar variability.

This is peak dose in millirems per year for this particular problem as a function of root depth.

Now, root depth goes from a little over about half-a-meter to 1.4 or so, and you can see this strong sensitivity to the parameter value.

This kind of sensitivity leads to uncertainty in our quantity of concern, which is the peak dose.

So, to characterize those three ideas, I drew this little plot, which is just a simple figure representing the relationship between sensitivity and variability plus your lack of knowledge, and the relationship that determines whether or not a parameter is -- the parameter uncertainty is particularly relevant in an analysis is a multiplicative factor of the variability and lack of knowledge and the sensitivities.

So, if either the sensitivity of the model to that parameter is very small or if the variability and your lack of knowledge about that parameter is very small, then the parameter is not -- the uncertainty in that parameter is not particularly relevant or is very unlikely to be so.

If both those variables or those measures are high, then that parameter is quite relevant to the analysis, and somewhere in between we have a potential -- potentially relevant to our uncertainty analysis.

So, I'd like to talk just for a minute about a particular aspect of sensitivity, just to make sure that these are clear.

In my talk, I'm going to be talking about general ideas that I think -- this is one of them -- that I think should be considered when you're performing one of these analyses, and here's an important one.

Traditional sensitivity measure is a slope at a point. That is, you're evaluating the change in dose with the change in that parameter value, and that's usually at a point, and it typically represents -- or all the other parameters are constant, in general.

So, you change one parameter -- in this case, root depth -- while holding all the other parameters at their base case values, and the sensitivity measures a slope.

So, it's important to realize that, with a relationship like this, the sensitivity is -- can be highly variable in itself. If you measure it down here, sensitivity is very low, whereas not too far away, the sensitivity can be quite a bit higher.

There are -- I don't know if this has been mentioned, but RESRAD and MEPAS currently have the capabilities built into them to do Monte Carlo simulations, where you randomly vary parameters and calculate a dose for each realization of those parameter values, and any code can -- you can set up a simple wrapper to do that, that sort of thing.

When we do that, we don't see a relationship like I showed in the previous slide, but you could still plot peak dose versus parameter value.

In this case, it's the same parameter, it's the rooting depth, and it's the rooting depth over the same range, and instead of seeing that sort of relationship like this, we see the scatter because of additional parameters that are varying also in this problem.

I think there's three or four other parameters here that were varied, and you see sort of this scattered relationship.

There are various measures, partial correlation coefficient, partial R-squared values, partial regression coefficients, depending upon what kind of analysis you're doing, that can measure something similar to the simple sensitivity but in the Monte Carlo sense, where generally these measures are trying to estimate some linear relationship between parameter value and your dose, and one other point I would like to make with this figure is that you can see here that the peak dose in this Monte Carlo simulation goes from around 10 to 20, a lot of these points here are about 18 or so, and goes all the way up to around almost 130 at the largest values of the rooting depth.

If we go back to that previous figure, which is -- has this parameter varying over the same range, but in this case, the rooting depth is the only parameter that's varying, you can see that the lower range is about -- the low number is about the same, but the maximum is only about 65.

So, when we just vary rooting depth, we see a maximum peak dose of about 65. When we vary other parameters in addition to that, the peak dose goes up to almost 130.

This points out that it's important in this sort of analysis to consider interactions between parameters. So, when you just vary it one parameter at a time, you don't see the full effect of possible correlative effects between parameters.

Now I'm going to move on, and I'm going to basically talk about two cases.

The first case is how to estimate parameter uncertainty when you don't have any site-specific data. So, in this case, we have such things like were discussed yesterday, national databases, regional information, that sort of thing, that we can use to get best estimates and uncertainty information.

The best estimates in this case are going to be limited, because there's no site-specific information. We have to understand what the national data represents in this case and what the limitations of that data are. We can't stretch the data any further, extrapolate that data any further than what it actually represents, and we need to be able to relate the national data to our conceptual model requirements and parameter uncertainty.

I’m going to talk just a bit about each one of those things right there, but first, I’m just going to give you an example.

This is an example of what we mean by a national database. This is taken from the Natural Resources Conservation Survey. It’s a soils database, and each one of these little red dots in here represents a particular soil sample.

There are almost 40,000 of these samples, and we’ve been able to derive approximate soil parameters classified according to texture.

So, for instance, we have thousands of samples here for loam soil.

We can look at those and derive distributions for a loam soil, and these plots just sort of show what those distributions look like for various parameters, both density, field capacity, residual water content, saturated water content, and these distributions can be used directly in a model such as RESRAD or MEPAS or any other model as long as we understand what they represent.

They represent small scale samples from across the country.

This is another example of some databases that are available. These are three other soils databases that are more limited in scope. They have fewer samples, but in contrast to the previous database, where very simple physical properties of soils are measured, in these the actual hydraulic parameters have been measured for each one of these points.

So, that’s something a bit more specific in terms of relating your site parameters to national -- or a national database like this. These samples of parameters were actually measures, so there’s less uncertainty associated with them in that sense, although there are fewer samples.

What is the relationship between a national database and site-specific data in terms of its uncertainty? What do we expect to see?

The national data represents variability of measurements made across the country, in general, or perhaps across a state or across some larger area, a county, something like that, whereas multiple site-specific measurements represent your variability at the site, spatial variability at the site, or temporal variability, and in general, we would expect to see something like this.

This is a plot of the probability density function which measures the likelihood versus the parameter value. The red is the national, and the blue is the site-specific. We expect to see a relationship like this, where the national variability is significantly larger than the variability we would observe on the site.

In general, this is the sort of thing that we expect to see.

I've already mentioned the consideration of scale, but just to hit it one more time, in general, measurements in these databases, soils databases, are made on a very small scale, a scale of centimeters, and this is just a representation of the model, DandD in this case, but we can see this illustrates the relationship between our scale of measurement and the scale of our parameter.

What DandD requires -- and MEPAS and RESRAD are the same way -- is this is our aquifer here,and we need a parameter value for this entire -- that represents this entire area, entire volume, whereas we might have measurements on this scale.

So, we can see that we're talking about an issue there that might be significantly important if our parameter values don't scale directly, which, in fact, they generally don't in most cases.

If we have some site-specific information, then a couple of issues arise.

We want to be able to combine any site-specific measurements we have with the information that we may have gotten characterizing uncertainty based on our national database.

We want to do that in a manner consistent with our understanding of the data representation and the conceptual model requirements.

So, what exactly am I talking about there? Well, I'm talking about something like this. The parameter uncertainties should represent the uncertainty in an average parameter value at the site, not the spatially temporal variability of the measurements.

That's because, like I just illustrated, these models -- RESRAD, MEPAS, DandD -- are looking for an average value, some sort of value that represents an effective number over a very large scale. So, if we're talking about the uncertainty of that parameter value, we're interested in the uncertainty of the average, not the variability across the site.

So, I represent that concept here, where this red line represents the probability distribution, perhaps, of a parameter value across a site.

So, if we took 100 samples from different locations at the site and plotted them up in a distribution, we would see this, but what the model is actually looking for is the average value, and therefore, the uncertainty that we put into it should represent the uncertainty in that average value which is going to have a much more narrower distribution, much more narrow distribution, in all likelihood.

In some of the work that we have done for the NRC, we've tried to look at this issue of combining national database information with site-specific information, and we developed a method to do so, and I'm just going to put two slides up here to illustrate the idea that we're talking about here.

This method basically takes information on the uncertainty from a national database, which is the blue, so this is a fairly broad -- a broad distribution of values for the particular parameter, and it combines that with site-specific information.

In this case, we've got two measurements of this particular parameter value from our site, and it produces an updated probability distribution of the average parameter value at the site, and that's this green line.

So, the purple line here represents the actual distribution of the parameter at the site, the spatial variability.

So, what the model is looking for is some kind of average value. This would be the expected value right about here for this actual distribution, the purple one, and with two samples, we see that our parameter and its uncertainty look like this.

So, we started out with the blue; we end up with the green. It's approaching -- the mean of the green is approaching the mean of the purple, the mean of the actual distribution, but its uncertainty is quite broad.

However, the uncertainty is less than the spatial variability that is the distribution of the actual parameter, the purple line.

So, we can see what happens if we add additional parameter measurements, additional site-specific measurements of that parameter. This is with two samples. This is with three site-specific measurements, and we can see the distribution of the green line, which is our updated distribution, is becoming narrower and more closely related to the mean of the actual, and if we add four -- if we have four randomly-selected samples, these four down here, we see that it gets even more narrowly distributed.

What's happening is the variance of the updated distribution is being reduced because of the additional information from the site, and we're shifting the mean of this distribution closer to the mean of our actual distribution.

So, in this sense, this method is combining the information from the national database and the site-specific data; it's doing so in a way that's consistent with the conceptual representation of the parameters at the site.

And I guess I'll just point out that that was a particular parameter, one single parameter value. We can then do calculations with that parameter.

In this case, the sort of calculation was for -- to calculate the net infiltration rate, and this more widespread distribution represents the uncertainty of the net infiltration prior to introduction of site-specific values, and after the introduction of site-specific information, we changed our -- reduced our average net infiltration rate and reduced the uncertainty about that net infiltration rate.

And just carrying that analogy one step further for this -- this is a particular example that we've run. This is total dose at 1,000 years and shows the difference between no site-specific information and using site-specific information for particular parameters. You've reduced the uncertainty in this case of the dose. The average dose has also been reduced.

I'm going to show a number of slides to complete my talk that deal with the particular issue that I've heard mentioned here, and I think it's important to make a few clarifying comments about this issue.

Essentially, we have two alternatives in the particular analysis that we're looking at. We can either do a deterministic analysis in which we end up -- we run a code, we end up with a single value, and we base our regulatory decision upon that single value.

So, the procedure here is choose parameter values using your best estimates, and uncertainty information can be taken into account, and some sensitivity analysis performed, perhaps, but you're estimating your uncertainty in the model results based on a sort of a deterministic analysis.

Alternative two is to do a stochastic analysis such as the Monte Carlo simulation where you choose the actual parameter distributions and you get a distribution of peak dose but then you have to choose some statistic from that dose distribution with which to compare to regulatory criteria, and do you take the mean value, do you take the 95 percentile, what do you use?

So, those are sort of the options that are available, and each one has a limitation or a difficulty.

So, I'm going to illustrate one issue related to this decision. I've heard -- well, let me just say that, if you take -- we ran some simple examples just to illustrate a fairly simple idea, but it's somewhat subtle.

This is a simple model where we have a single parameter X, and that produces a Y. In this case, the output, what you can think of as a dose, is linear-related to our parameter value X.

In this case, X is normally distributed, and this is a distribution -- this is just 100 samples of X, the parameter value, and we get out a distribution for our output, or in this case what we're thinking of as dose, that looks like this.

If we look at the average value of this distribution, we can see that that's 5.96. If we take the average X value and simply plug it into this equation, we get a value for Y, or our dose, of 5.96, also. They're the same thing.

It’s very easy to prove this analytically, mathematically, but I wanted to illustrate this issue.

So, the -- this illustrates -- among those two alternatives you have, do a deterministic analysis, where you might have information about the uncertainty of your parameter values, you choose the best estimate and you plug the best estimates of your parameters into your model. That gives you the same result as if you do a Monte Carlo simulation and look at the average value from the results of your Monte Carlo simulation.

That’s the case when the relationship between dose and the parameter value is linear, and that relationship is independent of the particular distribution for your parameter.

In this case, X is -- our parameter, our input parameter, is log normally distributed. So, it’s quite skewed, and our output, our dose value, Y, is also skewed, but the average value when you do the Monte Carlo simulation is identical to the value you get if you take the average X and simply plug it into your relationship. That’s because this relationship is linear.

If the relationship is non-linear, then we have a different case. If it’s non-linear, then you can see that these values are slightly different -- 5.29, 5.293.

That difference is inconsequential in this case because our coefficient of variation -- that is, the ratio between the standard deviation of X and its mean value is very small. So, the variability of that parameter is fairly small with relation to its mean.

That leads to a very small difference for this non-linear relationship, which in this case we took just to be a quadratic.

However, if that coefficient of variation is large -- in this case, it’s 2 -- we can see that the average value from the Monte Carlo simulation is significantly higher --about 20 percent in this case

-- higher than if we just take the average parameter value, put it into the model, and solve the model deterministically. We get a different value. That's because this relationship is non-linear.

In this case here, the relationship was non-linear, and X was normally distributed. So, it's a symmetric distribution for our parameter value.

If we take the same non-linear relationship but we use a log normal distribution for X, so that X is -- our parameter is highly skewed, then we see that there is a very significant difference between the Monte Carlo results -- so, this is the average value of the Monte Carlo simulation, and this is the value we get if we take the average value of X and simply plug it into our model and solve deterministically.

So, there's a fourfold difference there in the results.

And lest you think that this is all an academic exercise, this is an example from RESRAD where we were looking at the contaminated zone distribution coefficient for uranium-234. This is the relationship between peak dose and that parameter value, and we can see that it's highly non-linear.

So, even these simple models, such as RESRAD, MEPAS, DandD -- they have non-linear relationships between parameters and the -- our output that we're interested in, peak dose.

So, the issue that I've been discussing is of concern.

If you take that parameter value, assume a uniform distribution, and run the RESRAD in a Monte Carlo manner, this is the distribution for peak dose in 1,000 years that you get, very skewed.

Even though the parameter, contaminated zone Kd, was uniformly distributed, the output, peak dose, is highly skewed, and we see that the average from the Monte Carlo simulation, so the average of this distribution, is 232.

If we take the average peak dose -- rather, the average contaminated zone distribution coefficient, which was about 30, 35, we take the average value, 35, and simply plug it into the model to solve the model, you see that the peak dose -- that that result is 105. So, in this case, some measure like the median, which represents the 50 percentile, is more closely related, much more closely related to that deterministic dose.

This is an issue that NRC needs to consider. The conclusion that I draw from this is that you have a lot more information if you're generating this complete distribution than if you're simply looking at statistics of the distribution.

So, present all that information, develop it and present it, and base your decisions on what -- all the information that you can see.

I'd like to just make another point here. This cumulative distribution here is the distribution of the peak dose in 1,000 years.

So, in this case, we're solving -- we're running RESRAD 100 times -- and it could be in the other model, also -- we're running RESRAD 100 times, and each time we get a peak dose in 1,000 years, and this is the distribution of that, of those 100 results.

Now, this is not -- this distribution is not something that is easily obtained from RESRAD. You actually have to go into an output file and extract that information on your own, but I believe this is the distribution that NRC is concerned about and not the distribution of the dose at any particular time, distribution of the dose over 1,000 years.

So, you might consider some modifications to RESRAD to make this information more easily accessible to the user.

In conclusion, I'd just like to summarize some of the issues that I brought up here.

We use national databases for the uncertainty information and best estimates only in the case when we have no site-specific information.

Site-specific information, in contrast, should always be used if you have it.

Don’t throw it away unless you think that there’s something wrong with it, and I’ve illustrated a means by which the site-specific information can be combined with some uncertainty information that you’ve got from a national database.

The relevance of the parameter uncertainty is a combination of several things to consider model sensitivity, consider the variability of the parameter, and the lack of knowledge that you have about that parameter, and those operate in a multiplicative sense, so that if any of them is small, very small, then probably that parameter is not particularly relevant to your analysis.

Consider in sensitivity analyses the entire range of your parameter values and how those affect dose. Don’t just look at one or two values.

In this case, again, Monte Carlo approach, I think, is the better approach to take, because you get out a lot more information about the range of your parameter and effect of that parameter on dose.

And there’s no reason not to use it, since if you’re using MEPAS or RESRAD or frames, which Gene Whelan talked about yesterday, these sorts of capabilities are built in, they’re easy to use.

Be careful to distinguish parameter variability, spatial or temporal, from parameter uncertainty.

And I already mentioned this one. We have a tool that we’ll be working on making more easily accessible that combines information from site-specific source and a more regional or national source in a consistent manner.

And finally, realize that using average parameter values in a deterministic analysis doesn’t give you the average results of a stochastic analysis, and that’s the point I illustrated at the end of my talk there, and again, the conclusion to be drawn there is that you have more information if you look at the full results of the Monte Carlo than if you’re just looking at a statistic effect of the output.

So, that’s all I have, and I’ll take any questions.

MR. NICHOLSON: Thank you.

Before we begin our questions of Phil, I wanted to point out for those who weren’t here yesterday, this is being recorded. We have a courtroom reporter. Today, we have Mike Paulis, from Ann Riley & Associates, is our courtroom reporter today.

For those of you who want to make comments, questions, whatever, there are microphones in the aisle. Please come to the microphone, identify yourself and your organization, and speak very distinctly into the mike.

Are there questions this morning for Phil Meyer on his presentation?

Boby Eid?

MR. EID: Thank you, Phil, for this excellent presentation. You are hitting the points that always we are struggling with and trying to come to a conclusion. My comment is on the first conclusion that you made, the first point on the last slide, and you said -- the first one on the previous slide.

It seems to me you are suggesting that, when we use national data such as screening methodology, and we use input parameters all over the United States and using for all radio-nuclides, you are proposing to use the best estimate rather than the 90th percentile.

That’s what you are proposing? I would like to understand it more.

MR. MEYER: Okay. Yes, that’s a good point. Don’t necessarily equate best estimate with expected value. I’m not saying that the expected value is the best estimate. If you want to look at a conservative value, then maybe something, you know, like the 5 percentile or the 95 percentile or something on the tail of the distribution is more of a best estimate for you. That's a relative term, as opposed to the expected value, which is a quantitative mathematical term.

MR. EID: So, the definition of your best estimate is based on your judgement or based on your goal?

MR. MEYER: Sure.

MR. EID: Because the best estimate is not well defined.

MR. MEYER: Yeah, right. So, in this example, U-234, this distribution here, the range -- this is the relation between dose and that value, but the range of that parameter we entered here was about .2 to 70, which is the range of values observed.

Well, actually, some of those observations apparently were way out here, but it's sort of the range about what we saw to be the best estimate for this particular soil type from the paper by Shepherd and Tybo. So, in this case, the best estimate was here, and we want to look at a symmetric distribution about that, but in some other case, if you're worried about conservative value and you see a distribution like this or you see a relationship like this, you know, maybe your best estimate is someplace else, I don't know, but that's a problem-specific -- depends on what your objectives are.

MR. EID: But you showed in the distribution curves for these parameters that the tail of the distribution when you take the data for across the United States versus the regional or the site-specific data, you will have much narrower distribution, and the tail of the distribution for the United States is far away from the tail of that distribution for the site-specific or the regional, whereas if you look at the mean, it's much closer. So, when you try to compare and look at the variability and the sensitivity of the -- uncertainty in the parameters and if you take the tail, you are far away from the actual, you know, real case that -- when you compare.

MR. MEYER: Right.

MR. EID: So, if you go and take the 90th or the 95 percentile, this means you are still far away from the actual conditions based on the distribution that you showed on the graph.

MR. MEYER: Yeah, potentially.

MR. EID: So, if you assume that you took the tail of that distribution at the 90th percentile --

MR. MEYER: Yeah. This is the distribution for this parameter we might use in the case where we don't have any site-specific information, and in this case, I have just assumed that this is the actual distribution of that parameter at the site, the actual distribution, spatially variable distribution.

So, if you selected -- if a conservative value said you should select -- well, in this case, effective porosity, probably you would be looking at a low value if you wanted to be conservative.

So, if you picked a value down here, you'd be selecting one on the tail of your actual distribution, because they happen to match up, but the thing is, you don't know what the actual distribution is a priori, right? Until you get some information on that, you don't know where it is.

So, again, it's -- you could end up -- if we were looking for -- if we just assumed in this case that, instead of a small value being conservative, a large value is conservative, we could be selecting a value that's significantly beyond the actual occurrence of values at the site, but we don't have any information from the site.

MR. EID: I'm really trying to get that. If you are trying to analyze parameter by parameter without looking at the overall picture, what kind of scenario, what kind of assumptions, what kind of conservatism embedded in that scenario or in the model.

So, you are looking at the tail, taking the value for the tail of the distribution. If you take these values and you add it to the assumptions and conservatism in the model, this means you are far away from the real world of having -- you know, of real risk, and the question is where to go, to go closer to the mean or still to go to the end of the tail of distribution at the 95th percentile or the 90th percentile.

MR. MEYER: Yeah.

MR. EID: What is your perception? I'm trying to get to your -- from your experience, and that is what do you think, how far away you are from the real world when you go and take -- concerning all of these conservative assumptions when you take the tail of the distribution.

MR. MEYER: I think -- I mean a lot of people have showed that, with these kind of models, that if you build conservatism into all of your parameter values, you've got conservatism in your model that potentially you could end up with the result as your peak dose, could be significantly conservative.

So, in that case, you might argue that a mean value is closer to what you're interested in, but I think that depends upon the -- depends on the model, and in my experience, what's really valuable in these analyses is to look at relationships like this so that you understand, if you think this distribution -- if you think your parameter varies from .2 to 70, look at this relationship not only for varying just a single parameter like this but do it in a Monte Carlo sense, where you can get the correlative effects between different parameters.

I showed one of those plots earlier, but if you can understand what those relationships are, then you can understand -- that's an example for a single parameter, and that's an example of a Monte Carlo -- sort of a Monte Carlo sensitivity, where you can see the relationship between the parameter, but taking into account all the other parameters in addition.

So, doing both of these things, I think, helps you understand how these models react to different parameter values over the entire range of that parameter value potentially.

It doesn't mean that you need -- when you go to calculate a dose or you go to calculate the distribution of a dose, that you necessarily need to use this entire range. You know, there could be an argument for saying that that's not the case.

Certainly, if it's -- you know, if there's no relationship, then there's no reason to look at that parameter as varying or no reason to use the whole range, whatever, but it's in developing these kind of relationships that I think you can make decisions like you're talking about.

But ultimately, it's a matter of policy.

MR. NICHOLSON: Other questions or comments?

Yes, sir.

MR. KOFAR: This is Rick Kofar with Morton Associates.

As a point of clarification, did I understand you now -- we're using a lot of these models for kind of lump parameter type models, and what you're really interested is a measurement of the mean parameter and not the distribution of the parameter itself, so that what we should be developing are not necessarily just statistics on the parameter and the parameter range but statistics on the mean and the estimate of the mean.

MR. MEYER: Yeah. That is what I'm saying.

MR. KOFAR: Let me extend that a little bit further, then.

If we go to a national database -- and that's what we're primarily using -- let me back up. I'm not a statistician, so I could be -- definitely could be wrong on this, but my understanding on estimates of the mean are largely determined based on the number of samples you have, so that if you were to go to a national database where you have a huge set of samples, that your estimate on the mean would be very good on that -- from a statistical standpoint, because you have so many samples, so that then your statistical parameters for the distribution of the mean would indicate a very narrow range on the mean, and then, if you were to use that type of analysis and actually take your Monte Carlo analysis from that statistic, from that distribution on the mean, which is now virtually a single number because you have so many samples, that you've eliminated the uncertainty analysis in your performance because you have such a large data set.

MR. MEYER: Yeah. You've hit on a number of issues.

Number one, let me clarify that the approach that I advocate is not the approach that you've just described. You described a classical statistical approach where your statistics are based upon only your observations, okay, and what we're interested in is not -- what we're ultimately interested in is not -- doesn't have anything to do with what's in the rest of the country, right?

What we're ultimately interested in is, for a particular site, what's the parameter value that characterizes, for instance, the aquifer Kd or some other parameter.

MR. KOFAR: Then this approach is really for site-specific information more than for like a national database screening model type.

MR. MEYER: Well, let me just clarify. That's what we're ultimately interested in. So, what I advocate is that, because you don't have, typically, very many data points, very many site-specific measurements, you can't really characterize the uncertainty based upon the site-specific measurements that you have, because you don't have enough of them.

If you actually wanted to characterize the uncertainty in an average value at a site, it might -- you know, depending upon the variability of the parameter at your site, it might take, you know, 100 measurements or more, depending on the size of your site, the variability of the site. It could take a lot of measurements.

So, what I'm advocating is that you use a national database as an estimate of the uncertainty or the distribution that you might expect in that mean value at the site, and if that's the approach that you want to adopt, then if we think, for instance, that the -- if we think that the aquifer can be characterized as, you know, a sandy loam or a gravely sand, something like that, then that sort of gives us some idea of what the parameter value might be, right, and what the distribution of values we might expect because of what we know about what sandy gravels look like, or sandy loams.

We know approximately how they behave, and we know that based upon a lot of experience from across the country, different measurements that have been made on similar soils, so use that kind of information to characterize what you think the parameter range and distribution might look like, and that's your starting point, sort of.

MR. KOFAR: Let's bring this down to a more concrete -- so I can understand. Let's just take porosity, okay?

MR. MEYER: Okay.

MR. KOFAR: You know your material is a sandy loam.

So, you have some porosity measurements, and they indicate a range, but you also have a national database which is much more extensive that also indicates a range, but what you ultimately want to put in this model is still the mean --

MR. MEYER: Right.

MR. KOFAR: -- and a measurement of the mean and the variation -- the uncertainty in your estimate of the mean.

MR. MEYER: Right.

MR. KOFAR: All right.

So, you know you have a sandy loam based on your site data.

Now, we go to the national database, and we need to pick out a mean and some estimate of the uncertainty on that mean. Is that what you're saying?

MR. MEYER: No, that's not what I'm saying. What I'm saying is, if you want to know the mean value of the porosity of a sandy loam, the mean value across the country, then you could go to the national database, you've got 10,000 samples for sandy loam soil, something like that.

The average value has very low probability or very low uncertainty in it because you've got so many samples, but that's not what you're interested in. You're not interested in average value across the country. You're interested in the average value at your site, which you don't know and you don't have very many data points to estimate from.

What I'm saying is there's a national database which expresses the potential range of values that you could observe. I mean your site could be characterized by some of the lowest porosities that have been observed in sandy loam soil, but you don't know that a priori.

So, assume that that's unlikely, but it's not entirely impossible, that your average value at the site is very low, as low as has been observed in the national database. But then as you gather points and you see that your porosity is actually much higher, you should be eliminating those low values for the average at your site, because you're seeing a whole bunch of porosities that are much higher.

So, that becomes -- those low values become much less -- it becomes much less likely that that's the average value at your site.

Am I making sense?

MR. KOFAR: Yeah.

I think what you're saying is that you can use your national data as to guide yourself in reviewing your site-specific data to see whether it's likely to be truly representative or not, but there is still the risk that, in fact, you really do have a sandy loam or whatever that has a very low porosity based on site-specific characteristics, and if you go out and start gathering a few more points and you randomly hit a couple that are higher, it seems like to me you're starting to bias your site-specific data based on some national database where maybe your site-specific data -- there's a question of statistics, then, on your site-specific data, still, that you have to question whether you're really qualified or should be biasing your data, basically, on national data.

MR. MEYER: Yeah, there is always that question, and I compare it to your description where the variance of your data depends upon the number of samples you have. That's sort of a classical approach.

The approach that I advocated is what statisticians call a Bayesian approach, where you're not only interested in the observations you make but what sort of prior information or knowledge you have about a parameter, and you want to take both those things into account.

So, in this case, where we're updating this blue distribution based upon these samples and the result is this green distribution, what we're going to see is, if we take more and more samples, ultimately we're going to see the mean value of this green distribution is going to be equal to the mean value of this purple one, which is the actual site-specific mean.

So, the means are going to become the same, and the variance of this distribution is going to approach the classical statistical variance, as you add more samples, because you're relying less -- each sample you add means you're relying less on your prior information or the national database information.

MR. NICHOLSON: Okay.

Sir, identify yourself, please.

MR. NARDI: Joe Nardi from Westinghouse.

I guess it's just a comment. What you have done here is primarily look at -- in the one slide, you had the Kd for U-234. In real life situations, we're going to have a multitude of nuclides, and therefore, we're going to have more than just one Kd, we're going to have all of them, and it concerns me if we start taking a 90th percentile number for every single one of those parameters that's very sensitive.

We're going to end up with extremely conservative results.

MR. MEYER: Yeah. That's the issue Boby and I were talking about earlier, is that if you build in conservatism into each parameter value, you end up with a result that's potentially extremely conservative. I'm not advocating that that be done.

What I am advocating is that you look at the relationship between your parameters and your dose, understand how the models behave, not just with respect to one parameters but combinations of parameters.

If you have multiple contaminants and each contaminant is characterized by its own parameter value, then understand how those potentially interact to give you a dose.

MR. NICHOLSON: Do you want to make a point on that point?

MR. GEE: Previous point.

MR. NICHOLSON: Okay. We'll have Glendon Gee make his point.

MR. GEE: I'd just like to say, in the discussion we had yesterday, we were talking about the limitations of using the national databases, and I think Phil would agree with me.

If data were available, say from a county or from a state soil survey, that gave you information like the red distribution, you'd obviously choose that over the national database, because it -- the local information is always the best, but in the absence of that, Phil is pointing out that the uncertainty distribution values from the national database at least gives you a starting point. That's the point we're trying to make.

MR. SINI: Phil, my question pertains to your final conclusion, the last conclusion you had on your slide. The relationship, as long as it was non-linear, you said that the average parameter values in a deterministic analysis would not be equal to your average results from a stochastic analysis.

Is there any dependency on the number of samples in that broad conclusion? If you had more samples, would there be a closer relationship between your deterministic analysis and your stochastic?

MR. MEYER: What do you mean by a sample?

MR. SINI: When your average -- it goes back to the earlier question. When your average parameter value -- if you had a more -- less uncertain average value, would that change the -- how it correlates to a stochastic analysis?

MR. MEYER: Yeah. The example I tried to present, if the coefficient of variation is small, your parameters don't vary significantly in relation to their mean, then the difference is going to be small. It's a combination. If the non-linearity increases -- you know, my example is a quadratic -- if it's more non-linear than that, then the difference will be greater.

MR. NICHOLSON: Thank you.

Thank you very much, Phil.

MR. MEYER: Sure.

MR. NICHOLSON: We’d like to now move into a group discussion on parameter estimating for site-specific modeling, and if you turn to your agenda, you’ll see these questions listed in the back of the agenda. We’d like to go through as many of these questions as possible.

To lead us in the discussion is Mark Thaggard from the Office of Nuclear Materials Safety and Safeguards, and everyone in the audience is encouraged to participate.

MR. THAGGARD: Okay. Well, I think Phil did a great job of kind of priming everybody for this discussion. We’ve actually started hitting a little bit on this first question already, and it has to do -- well, we’ve kind of -- it can be broken up into two questions, really.

I think the bottom line is we can recognize that, at the sites for these parameters, there’s distribution of values, and one of the questions it has to do with, if you build a deterministic analysis -- I think Phil has done a fairly good job of illustrating that most of these dose analyses -- they are non-linear analyses, and so, I think, as followup to that point that Aby brought up, the last point in Phil’s slide, which value of these data should we be using in these deterministic analyses?

Is it appropriate to use -- if we’ve got like three data values for a particular parameter, is it appropriate to use the mean of those data values in the deterministic analysis given the fact that, as Phil has indicated, we may actually be underestimating the dose in some sense.

So, that’s kind of what this first question has to deal with, and I’d like to get some thought for comments on that.

Yes. Okay. Phil?

MR. MEYER: I’d like to make a comment, just in case I haven't made myself clear. I would argue strongly that, instead of looking at a single value, that you look at a range of values, because -- simply because that helps you understand the relationship between the parameter value and the model result, and if you understand that relationship, you can understand a lot of things.

If you -- if it looks reasonable and you believe that your model is giving you reasonable results, then just understanding that relationship helps you make decisions about what is an appropriate value, and if you see something that looks very strange, then there may be something going on in the model that you should be asking questions about, might mean that the combination of parameters you have is not appropriate and you need to look at something -- either changes in the parameter or changes in the model, look at something else, but you can't understand that unless you understand the relationship between parameter value and dose.

MR. THAGGARD: So, you're saying that basically it would depend upon the sensitivity analysis that should be done.

MR. MEYER: Yeah. And like I tried to characterize, I think a sensitivity analysis should consider the entire range of the parameter values, not just, you know, one value and take a high one and take a low one, look at that relationship, and there's no reason not to do this, especially if you're using RESRAD or MEPAS or one of these other codes, because the capabilities are already built in; you don't really have to do anything, you just run the model and look at the results.

MR. THAGGARD: Okay. So, basically what that's saying is that you're advocating that people should actually use the Monte Carlo analysis and that would get away from this whole problem.

MR. MEYER: Yeah, a Monte Carlo analysis, but you don't necessarily need to look at the -- a formal distribution of the parameter. If you're just interested in that relationship, you just put in a uniform distribution just to discern what the relationships are and understand how the model operates.

MR. THAGGARD: Okay.

MR. BIRKLAND: Rich Birkland, Siemens.

I think that, if you look at just a single parameter at a time -- I mean, for instance, you look at the Kd versus dose in here -- that that may not be the right thing to do, because there's a whole bunch of other parameters that are in there, and you may see a particular relationship using -- assuming something else for all the other parameters, but if you change those parameters and now you go back and look at your Kd, that relationship may be different. Do you understand what I'm saying?

MR. THAGGARD: Yeah.

MR. BIRKLAND: In other words, these parameters are interactive.

MR. THAGGARD: Well, that's kind of the same thing that Phil is saying, basically, that you need to do more of a Monte Carlo analysis, where you're looking at multiple parameters at the same time, as opposed to doing a sensitivity analysis looking at a single parameter at a time.

MR. MEYER: Exactly. I think that it's important to look at individual parameters, but you don't want to limit your analysis to that.

You also want to look at combinations like I showed, but the rooting depth example, once you take into account combinations of parameters, you can end up with doses that are significantly different because of the effective correlations between parameters and the doses that are significantly different than what you get when you just vary the same parameter.

MR. THAGGARD: Okay.

Henry?

MR. MORTON: Henry Morton.

It seems to me that, at least in my mind, there may be some confusion creeping in here that's related to the construction of the programs, and the difference may be that, in one case, we have probabilistic shelves which the users -- it's kind of expected to define the probabilities on the inputs, and the code is generating single valued outputs, whereas a different construction would have the user entering essentially best estimate values, and the code is doing a probabilistic treatment like Monte Carlo sampling on the models internally and generating a probabilistic output -- that is, an output which is a distribution -- and those, to me, seem to be different things that are coloring the discussion of the inputs.

MR. MEYER: I can just clarify that point. These codes don't operate by you entering a single value and then the codes generating probability distributions from those. They only operate by you -- if you want to look at the Monte Carlo simulation, you enter the distribution for the parameter, then the code will sample from that, generate a distribution of results.

The alternative is to enter single values or best estimates for the parameters, and the code will then run and give you a single value or result.

MR. THAGGARD: Okay.

Walt Bayelen?

MR. BAYELEN: Yes. Walt Bayelen, Sandia Labs. I just wanted to support Dr. Meyer's recommendation that the uncertainty in parameter values be considered, rather than focusing exclusively on a single value. I think it's an important mechanism for looking at the overall uncertainty in dose and consideration of the non-linearities and interactions parameters, the other issues that have been discussed.

MR. THAGGARD: Okay.

Why don't we move on to the second part of that question, while we're up here, since there seems to be a lot of advocation for the use of Monte Carlo analysis. One of the questions that people always ask is -- one of the concerns with using Monte Carlo analysis is that you have to describe the probability distribution function for these parameters, and that's often cited as a limitation to the use of the Monte Carlo analysis, and that may be kind of difficult when you've got a limited amount of data at your site.

Do we have any suggestions on how people might do that?

Can you identify yourself again?

MR. KOFAR: It's Rick Kofar with Morton Associates.

I was going to raise a slightly different point, but it sounds like, from what I just asked earlier, that the distributions we're looking for here in these lump parameter models are not the distributions of the parameter themselves and the variability of the parameter but the distribution on your estimate of the mean and the uncertainty in that estimate, which -- my statistics are really not very good but may be an entirely different distribution in itself, your estimate of the mean.

I might even venture to guess that that might be normally distributed, regardless of the underlying distribution. I don't know that for a fact, but that's in the back of my mind from eating statistics years ago. So, some of these questions of whether we have log normal or whatnot for some geologic data may not be relevant if we're really just using estimates on the mean.

MR. THAGGARD: Okay.

Norm Eisenberg?

MR. EISENBERG: I'm Norman Eisenberg from Division of Waste Management.

I think there are two issues here that are closely related.

I would like to suggest -- and maybe Dr. Meyer could tell me if he agrees with me -- that, in many cases, you are interested in the average value for the parameter in these lump parameter models, but perhaps a more apt term might be representative value, because sometimes you don't want just the arithmetic average; what you want might be a harmonic average or some other number that is appropriate for the function that the particular model plays and the role that the parameter plays in that particular model. That's one point that I wanted to clarify.

The other is this business about limited site data. You know, if you look at it one way, if you took one data point, well, it's real easy to get the average, and there's very little variance, but that obviously is not the right characterization of how much uncertainty you have, and what Dr. Meyer has suggested, which I think is a reasonable approach, is to use this Bayesian updating method, which starts out with a national database, assuming you know nothing about your site, and then as you get more and more site data, the impact of the national database automatically, because of the way the Bayesian updating works, becomes less and less significant, and the site-specific data and the distribution of that data becomes more significant.

MR. MEYER: I just want to thank Norm for bringing up that first point.

The idea of a representative value not necessarily being your arithmetic average is entirely correct, and in fact, it's potentially more serious than just having an average value, because you're really interested in what's known as an effective value, which the derivation of that is there's no consensus currently in the scientific community on the best way to derive an effective value from a series of measurements, but the effect of that effective value is that it’s just simply going to increase your uncertainty, and I think that, as regards the particular distribution, I think it’s less important to dwell on what particular distribution you’re going to be using and more upon relationships between parameter values, the model values, and looking at a range of parameter value inputs, and you know, if you’re concerned about distribution, then look at the effect of a couple of different distributions.

Look at a symmetric form, look at an asymmetric distribution, and see, if they both make reasonable sense, how the -- your results vary in using those distributions.

MR. THAGGARD: Okay. I think we’ve basically kind of touched a little bit also on question number two, at least Norm did, where we talk about how can we integrate this regional and national data with our limited site-specific data, and I think the appropriate that Dr. Meyer has been advocating is the use of this Bayesian updating technique, and for some people that don’t have a strong statistical background, they may not understand some of that.

I’d like to see if there are some other ideas out there that people may have in terms of how we can integrate this national data with limited site-specific data. Are there any other thoughts on that?

MR. NICHOLSON: One thing that didn’t come up yesterday when Dr. Neuman was talking about his site, instead of looking at national databases, you look at nearby studies that have been done, you go to the land grant universities and you go to the USGS to get open file reports, you find a study that has been done in a very similar geologic and hydrologic setting and say, well, for my purposes, I want to begin with that information and database and not do what you’re saying, Phil, in regard to looking at a national database to come up with these estimates. What are your thoughts?

MR. MEYER: I agree with you, and I think the approach that the folks at the University of Arizona have taken is good, but they also used the information from NUREG-6565, which was a compilation of a national database to look at values for their parameter starting points.

MR. THAGGARD: Okay. Why don't we move on to the next question here? What kind of information are available that licensees can provide to justify their site-specific parameters? I'd like to get a little bit of dialogue on that.

How acceptable is somebody coming in just using literature information? What are people's feelings on that? Any comments?

MR. MEYER: You're concerned about people coming in with literature values?

MR. THAGGARD: Yes. I mean that's just an example.

MR. MEYER: Being able to justify those?

MR. THAGGARD: Yeah.

MR. MEYER: I tend to think the literature values are just another example of something similar to national data. You know, it's analog data that somehow is related to your site but not a direct measurement from the site. It should be treated the same way.

You know, there's more uncertainty associated with that data than there is site-specific measurement, so treat it the same way.

You've got literature values for use, and you better have some sort of an estimate for what the range about that value could possibly be at your site. Maybe use a literature value as your best estimate, but there needs to be some other information in there, also.

MR. THAGGARD: Okay.

Tom?

MR. POTTER: Tom Potter.

I think we need to factor in some way qualitative information that is available from the site. For example, you were talking about license terminations here. Most sites have experienced small releases of radioactive materials at the sites, in the soils around the sites.

I think the experience generally is that those releases are quite well confined to the places where they were originally deposited, and over a long period of time, for many of these sites, 30 to 50 years.

You might not be able to translate that to a Kd directly, but it does give some indication of substantial retardation potential for the soils around the sites, and there ought to be some way to factor that in to support for selection of site-specific Kd value, something like that.

MR. THAGGARD: I think you're saying there needs to be some way to tie it back to the site.

MR. POTTER: Or more to the point, some way of using qualitative information to support some selection of quantitative values for important parameters.

MR. THAGGARD: Okay.

Any other comments?

Dr. Wierenga.

DR. WIERENGA: I'd like to make an argument for sometimes digging a little deeper.

For example, I once did a study for fuel properties of a large fire, and I went back to the person, who was close to retirement, but he did the original soil survey for that fire, and he had a wealth of information about the soils at that site.

It was really not considered in the official reports, etcetera.

So, one could, for example, if one needed more soils information, go to local soil survey people, and they could often give you a lot more information about the particular site, especially if you bring them to the site that you're interested in and that you're working with and want to know more about.

So, I think that is something you won't find on the internet, you will not find in local reports, but that still might be available.

MR. BELLINI: Frank Bellini, Duke Engineering and Services.

Before I was Duke, I was Yankee Atomic for 20 years-plus, and I'm a geologist by training, and I can tell you that this all becomes a little bit easier when you have a background in geology and soils, and of course, working at the plant sites, there's always a lot of good geologic information available there, although sometimes you need to dig it out or find the right person who can help you into it, because some of it, as you say, is not always as well documented as you'd like to see it.

People come to me all the time when you're using RESRAD and DandD and ask me, well, what Kd do we use and how deep is the ground water here?

When you're tied into the geology a little bit at the sites -- and I have been at all the New England sites, on a greater or lesser basis over 20 years -- it becomes a lot easier to deal with these questions.

Now, it doesn't mean you pull a Kd out of your pocket for a given radio-nuclide, that's tough, but at least you have some insight into soils, you have some insights into maybe 302 studies that have been done at the sites over the years, and see somebody else's estimates on migration rates and values for various radio-nuclides.

So, my suggestion would be find somebody that has some geologic background at the site.

Even if they're not used to dealing with the nuclear side of things, if you explain to them what you're trying to do, that help is out there on a professional basis, and I think it should be fairly easy to obtain for almost any site and might be a good supplement to just looking at the regional or the national databases cold, without any background.

MR. THAGGARD: Okay. I think you're saying, basically, use the expertise that's available. Okay.

Why don't we move on to the next question here? How does one assure the consistency between conceptual model assumptions and the selected parameter values? Can default values be used for different sites?

In my time here at the agency -- and I've seen a lost of dose assessments -- I've seen a lot of people routinely use default parameter values, and I think the question has to do -- how representative are these default values?

I'd like to get a little bit of discussion on that. Anybody have any comments on that? What are your thoughts on the use of default values? I guess nobody here uses them?

Tom Potter?

MR. POTTER: Tom Potter again.

I don't think there should be any controversy about using default values for pathways and parameter values that don't matter very much. I don't think we ought to spend a lot of effort on the pathways that we can easily dispense with.

MR. THAGGARD: Okay. I think that's a very good answer. I think that's kind of what we've been advocating over the last couple of workshops. We've tried to encourage people to go through and try to do some sensitivity analysis, as Dr. Meyer has indicated here, identify what the important parameter is, and you know, that's where you put your effort.

So, I think you kind of summed it up pretty succinctly there.

MR. MEYER: The flip side of that is that, if you have pathways or parameters that are important, then I think that default values are not appropriate.

MR. THAGGARD: Any other comments?

MR. POTTER: I don't think we ought to rule them out immediately. I think it's possible that you could use conservative default parameters, reasonably conservative default parameters that would be suitable, but I think there are certainly situations where defaults might not be appropriate.

MR. THAGGARD: Well, let me ask you, Tom, while you're standing there -- I don't mean to put you on the spot. Maybe somebody else could answer this, but how do you know that the default value is conservative?

MR. POTTER: Well, for example, let's take a re-suspension air pathway. There's one fundamental parameter that's highly uncertain but very important, and that's the re-suspension factor or the mass loading, that kind of thing.

I don't think there's much doubt that we can come up with reasonably conservative values for that. There's a default parameter.

MR. THAGGARD: I've gotten into some discussions on this before.

Especially as it relates to Kd, I've gotten -- people say, well, I used the conservative Kd value from the literature, and our argument -- well, how would you know that's conservative for your particular site, unless you've got some data for your particular site to support that.

Boby, you had a comment?

MR. EID: I would like to say that, for those models, it's good to have some insight about dose models, because they do have assumptions, and if you find those assumptions would be very related by inputting certain parameters, then you may not need to put that parameter. An example of the infiltration rate in the ND screen and the hydraulic conductivity, and you could see the relationship between both.

So, there is a specific assumption about the infiltration rate, and if you increase that amount, that infiltration rate is less than the vertical conductivity. This means the model could be violated. Those kind of assumptions -- they need to be revised when you try to use it and you input the parameter.

MR. THAGGARD: Okay. I think -- as a general rule, I think I'm hearing people say that you shouldn't just routinely use default values. Of course, they may be appropriate if the parameter doesn't have any effect on the analysis.

There seems to be some debate as to whether or not you should use default values if the parameter does have an effect on the result. I think Tom is saying there, well, if you can demonstrate that the value is conservative, it may be appropriate to use.

MR. MEYER: I would agree with Tom. My point that it's not appropriate is that it's not appropriate to just accept a default value. If you can justify it as being conservative or as being appropriate for your site, then fine. It's a totally different matter.

MR. THAGGARD: Okay.

Any other comments?

MR. HAMDEN: The one thing that's important to both questions three and four that hasn't been mentioned which should be obvious based on many experiences we have is the sensitivity analysis.

This is the most important tool for that, and I think also a sensitivity analysis would be effective, also, for evaluating if all values of parameters are acceptable or if they need to be verified and so on.

MR. THAGGARD: That's kind of what Tom has said. He said identify the important parameter, and I think one would use the sensitivity analysis to do that, to help guide you in doing that.

Okay.

Why don't we go ahead and move to our last question here? Should parameter uncertainty be factored into the model input to determine need for more detailed site-specific data, and if so, how?

I think we've already kind of covered this to some extent. I mean we could certainly -- okay, Tom?

MR. POTTER: I have one thought on this that is important. We do need to factor in uncertainty in some way, but we need to -- I think we need to keep the whole problem in mind when we try to do this. That is to say it's easy to focus on particular little -- we're talking about ground water in this couple of days, and it's easy to get overly focused in one particular aspect of the problem and overly concerned with uncertainties about one particular aspect of the problem.

I think a thing that Joe Nardi was making reference to earlier concerned -- that he made -- expressed earlier about piling on of conservatisms and things like that, getting us into another world, is a problem that I think we manage by keeping our eye on the whole problem, on the problem as a whole, which is to say we've got maybe on the order of 100 sites to terminate licenses here by going through this kind of complex analysis.

We've set our dose limits quite low, actually, 25 millirem per year. We've identified exposure scenarios that -- even for going beyond the screening basis, are probably going to be unlikely exposure scenarios.

The assumptions associated with some of those scenarios are probably not going to be very likely. For example, okay, we assume resident farmer but we also make him drink well water.

Well, he probably won't drink the well water. If he does drink the well water, he probably won't drink it from the upper aquifer.

And then we get down to calculating DCGL values, which is really what we're talking about here, using -- trying to factor in uncertainties in our mathematical model and our parameters, and then we finally go to the final status survey and again impose caution in assuring that our concentrations are not just below the DCGL, but we can prove with a higher level of confidence that they're below the DCGLs.

So, really, it's that whole chain of events that we need to factor -- that we need to think about the uncertainties.

Ultimately what we want and what the NRC needs and what the licensees need, as well, is a regulatory process that allows us to release these sites in such a way that they're not going to come back to haunt any of us later, and that's about all the uncertainty control we need. How we get that is going to take considerable judgement on the part of all of us, I think.

MR. THAGGARD: Okay. That's a very insightful comment.

MR. NARDI: Joe Nardi from Westinghouse.

I'd just like to add to Tom's comment here that, in addition to all of this, in our situation, we're trying to do that where we're trying -- we have a site with ground water and we're trying to get in this, you know, report that justifies DCGLs within the next week or two, and you know, what we're talking about is doing it with other kinds of Monte Carlo calculations or something else that are not available to me right now, yet I'm trying to do this in the real world with multiple radio-nuclides in a short timeframe.

MR. THAGGARD: Okay. Well, I don't think -- I think we need to step back and make it clear that we're not saying that people have to use the Monte Carlo analysis. I mean I think that was Dr. Meyer's opinion as to what he views, but as an agency, we haven't taken that position.

John Ellis?

MR. ELLIS: John Ellis from Sequoia Fuels.

I'd like to suggest that there may be another option for some sites, particularly like the Sequoia Fuels site. We've got about a 30-year history that's pretty well geologically documented before the plant was built.

We also have a 30-year history of repeated spills of various sorts, and over the last eight or nine years, we have done extensive sampling on that site, a lot more than anyone would probably consider doing under normal circumstances, tens of thousands of sample points to be more precise, but I think there's an opportunity here, with the number of data points that we have, at least, of building some at least qualitative estimations, empirical estimations of things like the Kd values.

We have got a lot of soil samples in the unsaturated zone from the surface down to the water table. You can look at the distribution of uranium from top to bottom, get extensive history on the precipitation patterns in the area. In fact, we collect rainfall data on a daily basis.

We also know quite a bit about porosities of soils, the percolation rates.

So, I think there's some ways of justifying -- actually developing and justifying Kd values, for example, nuclides that we're interested in just based on the data we have.

Similarly, for the saturated zone, we have kind of a -- maybe a unique situation at that plant, not only released uranium into the ground water but significant quantities of nitrate.

Nitrate is attenuated very little in ground water, in the system.

So, you can look at the progress of the nitrate plume over the history of the plant and come to some very good conclusions on ground water flow rate, dispersion, etcetera, then you can look at what’s happened to the uranium plume, and I really believe you can back-calculate some values for various parameters that would predict uranium movement that might give you a much better handle on what’s going to happen long-term than trying to arrive at it statistically using some of the methods that we’ve talked about today.

MR. THAGGARD: Okay. I think this goes back to what Dr. Meyer said at the beginning of his talk. I think his talk was focusing more on sites where you didn’t have existing ground water contamination, where you could do these type of inverse analyses as you’ve indicated.

I would like to say before we conclude, though, that certainly we are not saying that people have to use Monte Carlo analysis. I want to make sure that’s clear.

I mean I think the -- as an agency, I think that’s kind of our preferred method, but certainly, you can use deterministic analysis, and I think all our guidance documents say that.

With that, I would like to turn it back over to Tom.

MR. NICHOLSON: Thank you very much, Mark. Thanks for leading that discussion.

We’d like to take a break now for 15 minutes, and then we’ll reconvene, and we’ll listen to some test cases from DOE.

Thank you.

[Recess.]

MR. NICHOLSON: If I could have everybody’s attention -- Mike, are you ready? Mike’s ready. If everyone can please take your seats, we’ll get started now.

I want to thank very much the United States Department of Energy for providing two very good test cases that we can discuss with regard to implementing decommissioning issues in calculating dose assessments.

The first talk will be by Sam Lee, who works for the United States Department of Energy, their Environmental Monitoring Lab in New York City. His talk is entitled "Ground Water Modeling Studies of the Characterization of Uranium Contamination at Fernald," and it will be presented by Sam Lee.

Sam?

MR. LEE: Actually, it’s environmental measurements.

Before I talk, I’d like to thank Tom for giving me this opportunity to present my studies on Fernald.

During 1953 and 1989, nuclear weapon material were produced at Fernald in Ohio, and after 1989, the operation of production was stopped, and DOE re-focused on environmental restorations.

During these 40 years, ground water has been contaminated with uranium, and this study is a part of the effort to find out how much contamination and how serious the contamination is at the Fernald site.

At the site, a model has been used, such ‘s the SWIFT model, has been studied many years at the site. However, the SWIFT model is an old model originally designed for saturation zone only, and SWIFT model deals with the linear assumption process.

I would like to describe in more detail the linear assumption process.

EPA has questioned the SWIFT model result. So, therefore, they are trying to develop a reasonable and defensible ground water model that can be accepted through EPA.

In the meantime, we are trying to develop an advanced ground water model that can take into account more important physical/chemical process, and particularly for the talk, I’d like to emphasize this process, give the audience a little background.

Now, I'll give you some background.

I'm trying to use the TRACR3D model, which is developed to model the time-dependent mass flow and the chemical species transport in a three-dimensional, deformable, heterogeneous, sorptive process.

The computer code can calculate water flow or air flow and the transport of radioactive and sorbing species for a variety of flow conditions: steady state or transient state or the one-, two-, three-D geometries, or in saturated or unsaturated zones.

I'll give you more background of the TRACR3D.

TRACR3D was originally developed by the Los Alamos National Laboratories and has a long history of use for DOE projects such as Yucca Mountain, Nevada Test Site, or the Savannah River Site, and was used by Lawrence Livermore and Sandia National Laboratory, and FEMP at the Fernald site.

It has been verified and validated for a variety of flow and reactive transport conditions and has undergone many revisions and updates over a period of 20 years, and recently, the model has added additional modules to calculate the biological and colloidal transport.

It has the capability to the do the optimization for pumping operation or inversion data to get -- determine the flow and the transport properties and also has the capability to do the sensitivity analysis.

I think TRACR3D code is the most powerful modeling system available for porous flow and transport.

In order to use this model, I'll just give you some idea what kind of parameter we are emphasizing for the model, but for this talk, I am trying to emphasize what is the thermodynamic parameters such as the adsorption, desorption, and chemisorption.

In particular, yesterday and today, we are talking about the distribution coefficient. I'd like to give you some background on the distribution coefficient, what we had to use and how we can improve this distribution coefficient Kd, and it gives a little background in order to try to use the model, just like Boby said.

We have to know the model assumptions in order to do the better job. So, now I try to give you some background on how we improve or what kind of distribution coefficient it is.

Before I give you a description, I'd like to give you a little background of the model input we require at the site, such as hydraulic conductivities at the site. The minimum hydraulic conductivity can be 120 and 774. So, that is a lot of variation for the site.

So, in order to take into account all these variations, we tried to devise a different zone to take into account those spatial variations. This is the Fernald site, the operations site.

So, in this zone area, the hydraulic conductivity is 400 for all the layers, and for example, this is -- zone four -- the top layer is -- we are showing 638.

So, I'll just give you some three-dimensional view of hydraulic conductivity we input into the models, and so, that is a different area. We have used a different horizontal, the hydraulic conductivity, or the vertical hydraulic conductivity.

We take into account all the spatial variation at the horizontal or the depth.

How about infiltration rate?

At the site, we have a DOE measurement of the precipitation around 41 inches per year, and we calculate the run-off, probably nine inches per year, and this evaporation is around 26 inches per year. The recharge is around 6 inches per year around the site area.

And this is just to give an overview of the infiltration rate in the spatial variation, and I just pointed out previously, in this area, this is 6 inches per year, but in a certain area, it has a higher infiltration rate.

So, those is a variation of the infiltration rate input into the model.

Now, let's talk about the Kd. I'd like to emphasize on Kd distributions, because that is most people's concern for this meeting.

First, for the definition of the Kd, most people use a Kd under given conditions, such as the Kd is defined as the ratio of the mass sorbed into the solid and the mass of the solute in a solution, simply put by this equation: S=KdC.

S is the concentration of sorbing species, and C is the concentration of the solute.

So, look at this equation. It's too simplistic. Why is it so simplistic?

Using one parameter Kd is very bad for describing the complexity of the process or the areas. For example, for the site -- for the specific site, for Fernald, for example, at this area -- we are emphasizing on this area, and we can see that is a variation for the area can be from .76 to .68.

So, which volume we should use? That's the question on that, and it can have a serious result.

So, therefore, that's why it's -- I point out here there's a variance of the Kd, are very uncertain, from .76 to 68, and also, I'd like point out now that Kd, based on this equation, is linear, is not suitable for the study, for the long-term, for the model run.

We use only one Kd to represent a whole integration time. That is not correct. So, that's why we have to emphasize -- we have to know that is a Kd in a model.

So, that is, we have to remember that this is a Kd and may not be suitable for the time-dependent study.

How do we do it? Do we have another approach? Yes. Another approach is to use non-equilibrium conditions. That is, we have to consider another equation of the kinetic mass transfer among the different species, between the solid and the liquid phase.

So, in that case, we have to invoke another equation.

So, based on this equation, S is concentration of sorbing species, involves Q1, Q2, Q3, and Q1 is the adsorption rate, Q2 is the desorption rate, and Q2 is the chemisorption rate.

So, based on this equation, under equilibrium conditions, previous slide, under equilibrium conditions, this term is zero, and with chemisorption, this term equal zero, then we can come out that the Kd is equivalent to the Q1 adsorption species and divide by Q2, which is the Kd that involves only an adsorption and desorption rate.

So, that's what I want to point out to you. Chemisorption is important. If we use a Kd, we have some problem, because we use a Kd without considering any chemisorption.

So, that's what I'd like to point out to you and how important is Kd, and we have to know this is -- how important this is at a site.

If they have a chemical species and consider any precipitation or anything like that, Kd, no matter what kind of value you use, may not give us the right result, because they do not consider any of the chemisorption.

So, that's why I'd like to point out to you not only the Kd value, but we have to know what kind of assumption for the Kd. That is, Kd based on this one is only considered an adsorption and desorption rate only.

I will give you more of the model results, let you look at how important this assumption plays. I'll try to give you some model simulations.

First, I'd like to demonstrate -- yesterday or today, we talked about how important is the dispersion, and because I know that some DandD or the RESRAD did not consider any dispersion, I'd just like to demonstrate in an actual site how important is dispersion calculation.

So, in the simulation based on the model, we don't perceive any dispersion, and second, consider, with the transport in dispersion, how much difference, and it really demonstrates how important dispersion is, and then, the third test is a simulation based on equilibrium sorption.

That is a condition of Kd, and then is a simulation based on a non-equilibrium sorptioni with and with chemisorption and really to see how important the chemisorption is.

These are the initial conditions of the uranium concentrations at the top layer, and this originally is back to 30, 40 years ago. This is contamination only of certain areas, only around this area, but now has been contaminated. So, this is what we use as the initial condition at the site, this top layer, and this value is 20 pbb and the maximum up to 2,000 pbb around here.

The EPA requires it to be at 20 pbb, and this is the second layer, next to the top layer, and now the contamination goes down to the third layer already, a little bit there, but most contamination is accumulated at the top two layers.

This is the initial concentration of the uranium. We used these initial conditions and hydraulic conductivity infiltration rate input as input to the model and let it run.

Now, let's look at the results for the transport only.

This is the top layer. This is integration up to six years later. The initial condition is back to 1997. So, this is after six years' integration, without considering any dispersion.

So, this is very similar to the initial concentration.

This is the top layer, and this is the second layer, and we don’t see too much difference from the initial conditions after the six years’ integration, and now let’s look at that, compare with -- this is transport only.

This one is -- the top figure is transport and the dispersion, and in this case, we only used equilibrium sorption, and we can see the difference.

Next, please.

We can clearly see that, in the peak, it has been reduced, after considering the dispersion. Originally here is about 2,000 pbb and now is reduced to 500 pbb, and in here, it’s more dispersed than without dispersion. This is for the top layer.

Now, let’s look into another for the chemisorption. I’d like to describe it and how important this chemisorption.

So, this is initial -- the initial condition for the uranium concentration at the top layers, and after the six years’ integration without chemisorptioon, we can clearly see that the uranium plume hasn’t changed very much. There’s some changes but not much.

So, this is without the chemisorption, and the previous slide is for the equilibrium conditions, but now, if we run the non-equilibrium conditions without the chemisorption, we can clearly see that there is not too much difference between the non-equilibrium and the equilibrium conditions, but in this case, we are trying to use Q1 or Q2. Q1 is adsorption, and Q2 is desorption.

We tried to use the value of the Q1/Q2 equal to the Kd, which is equivalent to the equilibrium adsorption. So, we don’t expect too much difference, because in this case, we tried to compare with Kd.

So, that’s why we selected the Q1 and Q2, tried to get some balance based on that equation, get the same value of Kd.

So, we don't expect too much different from the -- from this result.

This one is the concentration based on the equilibrium conditions, and we don't see too much difference.

Also, we have to think about that that site has been contaminated 40 years. So, during this 40 years, maybe the uranium has been reached through the equilibrium conditions, maybe.

So, that's why we don't see too much difference between the equilibrium and non-equilibrium conditions. However, if we use -- add chemisorption into the model for the non-equilibrium conditions, this is initial condition for the uranium, and after six years' integration, we clearly see that the concentration plume has been reduced. That is indicating how important the chemisorption is.

So, in that case, this only can be under the non-equilibrium conditions, but with the equilibrium conditions, this chemisorption cannot be considered at all.

But we know that site has been detecting some other species, uranium species. That has been discovered, and some chemical precipitation is occurring. So, we have to consider some chemisorption process in the site.

So, in that case, based on that transitional Kd, we have a problem too complex for chemisorption, but in this case, we had to use non-equilibrium conditions in order to tackle the chemisorption, and we can clearly see that is a variation from that initial.

Look at those two. Those are year two or three with chemisorption, and this is year two or three without chemisorption, and we can clearly see that the plume has been changing, with and without chemisorption.

So, let me make some conclusions for the talk.

Based on the comparison between the transport and dispersion, we found that the peak concentration was reduced and the plume becomes diffused when dispersion is considered.

The second thing is we found that the model -- we tried to use a different adsorption and desorption rate, and we found the model results were not very sensitive to these changes between adsorption and desorption.

That's why I pointed out that, because probably uranium at the site has been reached to the equilibrium conditions.

And the third thing is the chemisorption process plays an important role in the fate and transport of uranium plumes and enhance the mass transfer process. That is, we have to consider in the model simulations.

So, that has been neglected in most of the models. We have to consider that in order to give us the right plume, contamination plume.

So, that's why I pointed out additional measurement data is needed to verify how important this chemisorption process at the different sites.

If a site has this chemical reaction and precipitation, we have to consider this chemisorption in the model.

Finally, I'd like to give some recommendations, and I think that, at the site, Fernald, we have tremendous measurement data of variable and all kind of data we can use for the model test.

So, I'd like to continue to use Fernald as a demonstration site or test site to further examine the ground water model related to dose assessment in the future, how important is the ground water model, because in that case, we'd like to continue to use this elevated TRACR3D to identify the important key parameters that have a maximum impact on the risk assessment, such as yesterday Carol described some key parameters.

So, we can use this, TRACR3D, to try to validate, because she pointed out just based on the DandD, but now we can use this as an elevated TRACR3D to try to validate her finding and that kind of stuff.

So, in that case, we have tried to continue to identify that as a key parameter and also tried to see how the maximum effect or the geo-chemical or geological condition on transport.

That is the end of my talk.

MR. NICHOLSON: Thank you very much, Sam. I really appreciate that.

Are there any questions for Sam Lee on the Fernald site?

Tom?

MR. POTTER: Tom Potter.

The term "chemisorption" -- we could probably stand to have some elaboration on that. What kind of chemical processes do you -- have you described here that result in this -- apparently, it results in a more rapid transport of uranium through the ground water system than we would otherwise get.

MR. LEE: I’m thinking that, at a particular site, if we have some secondary species, if we found a secondary species, maybe we have to worry about some of the chemisorption there. That’s the main thing.

MR. MEYER: I had the same question as Tom, but you didn’t really answer what do you mean by "chemisorption"?

MR. LEE: Oh, okay. Chemisorption is actually the irreversible process. A sub-species is transformed to the chemical bonded state. That is chemisorption.

MR. MORTON: Henry Morton.

I was thinking in terms of the condition in which you might have chemically-processed material leaking into the ground and, thus, a chemically-active form of uranium to begin with, but then realizing that the long-term tendency may be toward a more stable form -- iridium oxide-308 is a long-term environmental tendency -- and that from a leakage situation which might be the more active form, a nitrate chloride form of uranium, the nitrate or chloride tends to move on out faster, with the prospect that there is a change in the chemical form from a more mobile to a less mobile form, whether you'd call it a change of compound or precipitate.

What term, what parameter would you quantify in your program or in your model to account for that kind of condition? Is that what you were calling -- or what might come under the equivalent term of "chemisorption," or is there a separate term for precipitation?

MR. LEE: That term should be -- everything should be put into this as Q3, the chemisorption rate. So, in this case, we have shown that we just take that Q3 is about a three-magnitude order than the desorption rate.

But this is the equation. We can have different species, can involve different species, if we have more than one species, and we can have a different Q3 for different species, and all this is precipitated. The chemical can be considered a different value of the Q3.

MR. MORTON: Are you developing these -- the values of the parameters that might deal with this in your modeling, for example, considering applying to the Fernald case?

MR. LEE: Yes.

MR. NICHOLSON: Are they derived from the field?

MR. LEE: I'm taking based on the literature survey at this point. I need additional field measurement to try to validate the chemisorption process.

MR. MORTON: So, then, to apply this, for example, in the Fernald case or to John Ellis' case, where he, for instance, over --

even over relatively short times, may not be seeing actual migration that would be explained otherwise, when applying this to very long time-frames, hundreds or thousands of years, what would you do as a practical matter -- that is, to an applied case -- to gather the data to be able to apply this quantitatively?

MR. LEE: For longer than 1,000 years, how do we know this value is validated, that kind of stuff? Is that your question?

MR. MORTON: Or even over 50 or 100 years.

MR. LEE: At this point, we don't know. Nobody knows what kind of value we should get -- Q1, Q2, and Q3 -- and the only thing we can -- for the short time period, 10 years, if we have some measurement, we can compare that measurement with the model results to get the best judgement of the Q values.

MR. NICHOLSON: Okay. We'll stop there. Thank you very much, Sam. We're going to have a group discussion on this after lunch, but I want to get to our next speaker. Thank you very much.

Our next talk will be by Ken Renfeldt and Barbara Deshler.

Ken is with HSI GEOTRANS, and Barbara Deshler is with IT Corporation, and they're going to talk about the ground water water modeling in support of dose assessment for the Nevada test site underground test area project.

MR. RENFELDT: I want to thank Tom and NRC for giving the opportunity to be here. As Tom said, I'm with HSI GEOTRANS. We are a subcontractor to IT Corp., which is where my colleague, Barbara, works.

IT is the primary subcontractor to DOE at the Nevada test site for environmental restoration, and what I want to talk about is some of the modeling that we're doing at the test site, and I was thinking about this last night, and in a way, I feel a little bit like John Clease, because I think what I'm going to show you now is something completely different in terms of the magnitude of the problem and the scale, etcetera.

Our problem is actually very similar to yours. We need to predict or assess the risk to receptors posed by radio-nuclides, but the location of our radio-nuclides and the source is a little bit different.

We have radio-nuclides in ground water, and it's in the ground water because of 40 years of nuclear testing at the Nevada test site.

There are about 828 announced underground tests at the Nevada test site. About a third of those are believed to be either below the water table or close enough that they've directly impacted the water table.

If you're not familiar with the test site, it's in the southern part of the State of Nevada. It's this area outlined in purple here. The yellow boundary represents the -- a regional model area that we started out with.

We had to put the whole flow system into a regional context, and so, we started out with this area here. It extends down into Death Valley over here. The City of Las Vegas is out to the left here -- or to the right. It's about 70 miles from the test site.

What you'll notice here is, geologically, this is all based on the range topography. So, we have just a series of mountain ranges and valleys repeatedly throughout the whole study area.

On the test site itself, we've got -- this is the distribution of the 800 or so underground tests, and we've grouped them into different testing areas.

Some of the areas have a relatively small number of points, such as here, where there was 10 underground tests. Up in Frenchman Flat, there was about 700 tests.

These tests, to give you some idea of the size of these, they are cavities underground that were vaporized, that have a diameter that ranges between 100 and 200 meters, and for source concentrations, tritium, for example, is in the range of 100 million pico-curies per liter, sometimes a little higher, and that's just the tritium.

So, we have a very significant source term here, and DOE is concerned about transport of radio-nuclides from these testing areas.

In general, what's happening -- and I guess I'll do it on the other scale -- ground water is moving off the test site generally toward the south and west, and we've got population centers, a small one over here, in Oasis Valley, there's people who live down in Ash Meadows, of course you've got the national park in Death Valley down here. So, there's certainly a concern for where these radio-nuclides are moving and how quickly.

What I wanted to go over, after speaking with Tom a little bit, were some of the considerations that we had in selecting the kind of ground water model that we would use, and you remember from Dr. Neuman's talk yesterday, the first thing we looked at was our conceptual model.

Where is ground water flowing? What are the geologic, hydrologic controls on that ground water flow? What processes do we need to simulate invection, dispersion? Matrix diffusion is a big issue for us because of fracture flow, radioactive decay, and of course, what are our sources of contamination?

And we also looked at the complexity of the geology and the fact that we have three-dimensional flow, which is a big issue.

The other thing that we considered in our choice of modeling is what available data do we have? We certainly have water levels, some discharge measurements, at least at the land surface, Death Valley and other places.

Recharge is an estimate, at best. We do have flow and transport parameters, and the hydrologic source term -- as I mentioned, we have some very high tritium concentrations. That’s based on some limited measurements.

Once you go beyond that to the 50 to 100 other radio-nuclides that may be important, we have considerably less information.

Complexity was a big issue for us. The Nevada test site is the size of the State of Rhode Island. The regional study area, which included that yellow boundary of the model and a slightly larger region, is about 11,000 square miles.

Test cavities range in elevation from 500 meters up to 2,300 meters. Study area elevations go up to more or less around 12,000 feet down to below sea level in Death Valley. So, we had a huge range in elevations and source locations.

Depth to ground water is up to 700 meters below land surface, and of course, in discharge areas, it’s at the lend surface.

Last time I counted, we had about 250 different geologic units to worry about that range from pre-cambrian quartzites to quarturnium alluvium, and then, on top of that, in the tertiary, we had a volcanic caldera complex that developed which made a mess of everything that was left.

This is a schematic cross-section from the north to the south through the whole study area. In this case, the test site would be a region roughly in here.

We’ve got underlying basement rocks of very low permeability, down about 4,000 meters, a large carbonate aquifer system here and here that is the major flow system throughout southern Nevada and is the primary aquifer of concern because of transport off-site.

This system -- there is a series of older thrust faults in the carbonates that move it around in juxtaposition to other older clastic rocks.

In the middle of this, you've got the tertiary volcanic complex in here, which has some confining units, some aquifer units, and then sitting on top of those in the valleys, of course, are the alluvium.

Within a portion of the test site -- this is the southeast corner, a place called Frenchman Flat -- we have a situation where there's a shallow aquifer, which is alluvium.

It is the location where we have underground tests here and here, and we have what appears to be almost a radial flow system in that alluvium, yet the carbonate aquifer below it is flowing to the southwest.

So, we have places on the test site where we've got ground water going in 180 degrees opposite direction.

In terms of available data that we have, again speaking regionally now, there were 2,400 locations for water levels.

A primary source of water level data is the U.S. Geological Survey, but it's supplemented by a number of other organizations, including the Desert Research Institute, Bechtel, Nevada, IT Corp., Yucca Mountain Project, Livermore and Los Alamos national labs, and Nevada State Engineer.

The thing to point out here is that we have a very non-uniform distribution of water levels.

In the testing areas on the test site, they are very dense areas of wells. Off the test site, to the south, in the Amargosa area, where there's irrigation, there's a lot of water-level data.

There are other places where you can go 200 miles and there's no wells. It's a very dispersed data set.

Same thing with hydraulic conductivity data.

When we get to transport parameters, it gets very difficult. We have some tracer test data for dispersivities, but generally rely on, quote, "the literature."

There was a study done by Lynn Gelhar where he summarized dispersivity values. Shlomo Neuman did the same thing. We tend to rely on those where we don’t have specific data.

Matrix diffusion -- there is -- just now we’re getting site-specific data at a field scale on diffusion, and then, in general, though, we tend to rely on expert elicitations from NTS experts, from a variety of organizations, and so, we rely on them to help us bound not so much mean values but a range of variability.

So, what -- all of these factors drove our model selection. We have a very complex geologic system, very complex flow system, and we do have data, somewhat limited in many cases, but three-dimensional data.

So, at the regional scale, we’re doing three-dimensional relative flow using mod flow to help us bound input and output through the test site, and then, when we go to smaller scales -- for example, when we want to simulate a testing area such as Yucca Flat -- we go to more complex codes such as SWIFT or FEHM or something of that genre.

We bring in factors such as temperature dependence because of the heat, of course, created by the underground tests, plus it’s a geothermal area, so we have temperature effects that may be important.

At this point, we’re considering them but haven’t actually brought those into the models, but both of these codes have that capability.

We have some unusual or maybe different regulatory drivers than you may be familiar with. Right now, of course we have to worry about DOE orders. DOE has certain requirements to protect their own people on-site. There are drinking water standards, because we have on-site water wells.

But the primary driver for our modeling is something that’s called the Federal facility agreement and consent order, and that's an agreement signed between the State of Nevada, DOE, and Department of Defense, and what we do is we define a contaminant boundary region, and that's a region which is a lateral boundary in the deepest affected aquifer for which the dose may exceed 4 millirem per year at any time within 1,000 years, and schematically, what that looks like is we have a source, which could be a single underground test, it could be a whole series of tests, and first of all, we look at what's our expected region where composite dose would be above 4 millirem, but beyond that, we're also looking at a region on the outside of it which includes uncertainty, data uncertainty, spatial variability, etcetera, and what I've put in here is 95-percent probability that it won't be exceeded beyond this boundary.

I don't know that we'll ever get to 95 percent, but what we're aiming for is a high degree of confidence that we can define a boundary beyond which we're quite sure concentrations will never be above -- or the doses will never be above 4 millirem per year.

The 4 millirem per year is actually a proposed dose that DOE has proposed to the State of Nevada, and it has not been agreed to yet by the two parties. Where it came from was the State Drinking Water Act is the maximum dose rate for beta-photon radiation.

So, that's currently what we're proposing as our dose boundary.

The conversion of concentration data to dose comes from an exposure scenario which is a drinking water ingestion of 700 liters per year for 70 years, and the way we calculate that is we use that ingestion rate of 700 liters per year, for each isotope we calculate a concentration in our models in terms of pico-curies per liter, we use a dose conversation factor which came from Federal Guidance Report No. 11, sum these up for each of the nuclides, and that gives us a composite dose rate.

Now, we do this at each location, at each point in time. So, my expectation is that we are over-estimating the dose through this process, because that dose calculation assumes a 70-year ingestion time, and we’re actually using it in an instantaneous mode.

I’ll quickly go through the modeling process.

We calculate this 4-millirem boundary based on a testing area scale model -- for example, Yucca Flat or Frenchman Flat -- but these models are sitting in the middle of a much larger flow system, and we don’t have any flow boundaries within any of these desert basins. In other words, Frenchman Flat has no natural discharge. Its discharge is 30 miles away.

So, we use that regional three-dimensional model that I showed the yellow outline earlier to provide boundary conditions for a smaller-scale model.

So, we’ve nested a model in here, and on top of that, because our source information is so uncertain, colleagues at Lawrence Livermore National Lab have developed a source term model which, again, is three-dimensional, and it’s nested inside of our testing area scale model.

The regional model brings in many different factors into consideration. The conceptual model, of course, where is water moving from, where does it go to -- I mean that’s essentially our target, and once we’ve decided on a conceptual model, that’s what we’re trying to match with the regional model. There’s a geologic model which describes all the different geologic units and their position relative to each other, then hydraulic heads, discharge parameters, etcetera.

That regional model is calibrated to heads and discharges.

We did two things with it -- one, we did one-dimensional transport along pathways from the regional model, just to give DOE an initial sense of what kind of risk are we dealing with, how far away might these radio-nuclides go, and second of all, it provides the boundary fluxes for our testing area scale model.

The source term model starts with a radiologic source term.

This is known reasonably well to people at the national labs who have clearances because of -- whether people are familiar with it or not, anytime there was a nuclear test, nearly all of them had drill-backs, they went back and drilled into these and sampled cavity material at the bottom for diagnostic reasons.

So, they have a pretty good estimate of what the total radioactivity would be, but that's not what's available for the ground water.

Then you incorporate mineralogy, phenomonology, which is essentially cavity physics, what happens underground after one of these tests is detonated, local ground water conditions, and then they have a very large thermo-dynamic database.

Essentially what Livermore is doing is a coupled reactive transport ground water flow model, and they calculate the release rate of radio-nuclides from the cavity materials from the melt blast into the ambient ground water flow system, taking into account all of the different reactive transport mechanisms between the nuclides and the geologic materials, and what they provide to us, then, at the testing area scale is radio-nuclide flux, so many moles of tritium-3 or so many moles of plutonium, etcetera.

Model calibration -- we spent a great deal of time calibrating our regional model using hydraulic heads and discharge information.

When we get to the testing area scale model, we still use hydraulic heads, because we've got water-level measurements, but because there are, in almost all cases, no natural discharge in the testing area, we cannot calibrate to anything. So, we use the boundary fluxes from the regional model which has been calibrated to provide that for us here.

The source model is, by and large, un-calibrated. There is some limited information on concentrations in ground water. I don't think there's anyplace on the test site where I can map a plume. I know where there are radio-nuclides that exist in the ground water at a few selected locations.

The cost of collecting radio-nuclide information near these cavities is enormous. The depth to ground water is very large, 700 meters in some cases. These holes typically cost us a million to two million dollars apiece, and it's simply infeasible to map plumes from these underground cavities.

So, we do some limited calibration of these source models to whatever existing data we've got, but wouldn't be fair to say that these are calibrated.

So, we look at uncertainty, certainly, in the input parameters, and all of that gets back into our testing area models.

We do have uncertainty that comes from a large variety of sources. We have alternative conceptual models. In an area as complex geologically as the test site, you have different geologists who have different interpretations, and so, we look at those and try to determine what uncertainty that provides us in our predictions.

Parameters themselves are uncertain because of measurements, and finally, we've got just the whole issue of spatial variability.

We handle these things through a limited number of Monte Carlo realizations of our models, but basically, all we're trying to come up with is can we bound where the contamination is likely to exist so that we can go to DOE and DOE can go to the state and say here's a region, here's a circle on a map, and we don't believe there's contamination outside of that.

The last thing that we are starting to work with now is the question of what I'm calling model acceptability. Once we're done with our predictions, these predictions have to be acceptable not only to ourselves but to our client, which is DOE, and then to the State of Nevada.

One way we do that is to carefully document what we're doing, which I think is just standard practice. We look at corroborating data and try to do a reality check on our predictions.

We'll look at geo-chemical data, observe parameter ranges, anything else that we can do, see if our predictions seem to make sense, and finally, just recently, we've convened a review panel.

There's actually two review panels. There's an internal panel, which is NTS, knowledgeable experts, particularly the national labs, the USGS, etcetera, and then we've also convened a panel of what I call imminent experts, and Dr. Neuman is one of our panel members, and they are there to provide us some oversight in terms of the approach, is our methodology reasonable, are we using the correct tools, are we analyzing our data correctly, etcetera, and that's all I've got, if there are any questions.

MR. NICHOLSON: Thank you very much, Ken.

Are there questions for Ken and Barbara?

Sam?

MR. LEE: Just a comment. You just pointed out that you use a map flow for the flow and the SWIFT model for the transport. I'd just mention, just comment that those two models is designed only for the saturated zone only.

MR. RENFELDT: Oh, absolutely. We only worry about the saturated zone. It's not that there isn't a great deal of radioactivity in the unsaturated zone, but at this point in time, since we know we've got several hundred tests that are below the water table, that's our primary concern right now, and so, we're restricting ourselves to the saturated zone.

At some point in the future, 20 years or so, we may worry about the other tests, but right now our primary concern is saturated only.

MR. ALLARD: Dave Allard, State of Pennsylvania.

Have you seen any tritium or other soluble radio-nuclides, chlorine-36, off-site?

MR. RENFELDT: No. As far as I know, there has never been any detected radioactivity in the ground water off-site.

MR. ALLARD: Are you guys looking at any of the off-site test areas?

MR. RENFELDT: Those would be --

MR. ALLARD: Off-site test areas.

MR. RENFELDT: Yes. We have looked at other sites. There's the salmon site in Mississippi, several sites in Colorado and New Mexico, yes.

MR. ALLARD: Right.

MR. RENFELDT: That's a separate project from the one I'm working on. There's another group looking at those.

MR. ALLARD: Okay. Thanks.

MR. NICHOLSON: Sam Nallaswami.

MR. NALLASWAMI: Sam Nallaswami, NRC.

Your limit was 4 millirem per year. What is the maximum dose you got?

MR. RENFELDT: I'll trying to think. If I look at the cavities themselves -- I mean I don't remember the exact conversion, but converting 100 million pico-curies per liter of tritium, probably 1,000, 2,000, maybe 10,000 millirem per year, I don't remember, and that's just tritium.

MR. NALLASWAMI: Okay. Thank you.

MR. NICHOLSON: Norm Eisenberg.

MR. EISENBERG: Norman Eisenberg from NRC.

In calculating the 4-millirem limit, do you assume that the receptor drinks the concentration that's in the aquifer, and do you make any allowance for the likelihood that, in such a dry area, in order to get usable quantities of water, you would have to pump in fresh water, as well as -- or draw in fresh water, as well as the contaminated plume?

MR. RENFELDT: Do you want to answer that one, Barb?

MS. DESHLER: The State of Nevada considers the ground water to be the receptor. It's kind of a strange concept. So, no, we don't include any other ground water than that.

The water that's ingested is the water we're modeling.

MR. NICHOLSON: Any other questions?

[No response.]

MR. NICHOLSON: Okay. What we'll do, then, is we'll break for lunch.

When we reconvene, if the people at the table now would come back and sit at the table, Dr. Ralph Cady will lead us in a group discussion. If we could all get back here promptly by 1 p.m., we'll start the group discussion, and then we'll have a break and we'll have another group discussion.

Those people from industry that want to make some statements this afternoon, extended comments, please come and see me or Dr. Ralph Cady during the lunch break. We'll meet together at one o'clock.

Thank you.

[Whereupon, at 11:45 a.m., the workshop was recessed, to reconvene at 1:00 p.m., this same day.]

A F T E R N O O N S E S S I O N

[1:10 p.m.]

MR. NICHOLSON: We're ready to start now.

For those of you who have been paying attention to what's out on the desks, we have quite a bit of material out there, but we're trying to make more copies.

For those of you who have been keeping track of the hand-outs, we have run out of a few, so we're making some more, and hopefully we'll have all those by the next break, and then we have two presentations, Ken's and Shlomo Neuman's and also Sam's. We're making copies of those. So, we haven't gotten any of those yet, but those should be available also during the break.

So, if you just have the patience, we'll get those for you.

Also for those of you who have been paying attention, there has been a publication out there -- I don't know how many of you have picked this up. It's some information from the NRC, and I asked Bob Nelson to talk to you just briefly about what this document is.

Bob is Chief of the Special Projects Branch, Decommissioning Branch, Division of Waste Management of the Office of Nuclear Materials Safety and Safeguards.

Bob?

MR. NELSON: Okay. If you haven't picked this up yet, this is the first 10 modules of 16 for our Standard Review Plan for decommissioning materials facilities. We're publishing it for review and comment, and it's out on the table. Please pick up a copy. We're interested in your comments.

It's not complete. As I mentioned, there's only 10 of the 16 modules. There was out there also a one-pager on the status of the modules and when we expect to complete it.

The other six we hope to have up by the end of July. We probably would have made the end of June if it hadn't been for some vacation schedules. So, we're pretty close to complete on the SRP, with one exception.

I want to just discuss a few of the modules with you, so you have some background on this.

First of all, the Standard Review Plan is intended to provide guidance to the staff on what they need to do in reviewing a decommissioning plan or other decommissioning submittal, and clearly, it can be used by licensees in preparing a plan, because it pretty well lays out what we expect to see.

As I mentioned, the 10 modules we have up are on this sheet. If we need to make more copies of this, we'll have that done.

The two that I'll talk about briefly, that we've already developed, are the facility description, which is module three, and the alternatives to decommissioning, which is module six.

Module three, if you read it, requires a rather large amount of information, but if you read the explanatory note, it's really a worst case requirement.

It is tailored to those sites that have contamination at depth, that have ground water contamination, and are going to require some pretty extensive site-specific modeling.

So, if you're in a -- ultimately, when we publish the -- go final on the SRP, we'll have a little bit more guidance in there about what you need to supply if you're not in that case, but as you're reading that module, the SRP, understand that it's kind of a worst case situation.

The other module I wanted to explain briefly is module six, which is alternatives.

Now, this module will only apply if you're applying for restricted release. So, if you're in an unrestricted release mode, you can ignore module six.

Module six is intended to supply us with the additional information that we would need to develop an extensive environmental assessment or, if the need dictates, an environmental impact statement, without coming back and asking you for a separate environmental report.

So, the combination of module six in conjunction with the other information that we’ve outlined in the SRP should suffice for meeting both our safety requirements in Part 20 and our environmental review requirements in Part 51.

So, that’s a short explanation of those two.

What we haven’t released yet is the dose modeling module. One of the reasons we haven’t is because we’re still discussing that, but we will have a preliminary module on that out by the end of July, but it will only address screening.

You might ask why do I have to do any modeling if I’m going to meet screening criteria. Well, you don’t have to do any modeling, but you will have to justify your source term and the fact that your site conditions meet the conditions for screening. So, it’s pretty simple if you’re in a screening situation.

The complete module, dose modeling module, won’t be available until sometime next year, after we’ve concluded all these workshops and gone back to the table and decided what’s needed for site-specific modeling.

Any questions on the SRP?

Yes, sir. I think I know what yours is going to be, but go ahead.

MR. GENOA: Yeah. Paul Genoa with NEI.

There was some confusion on our part as to whether it was applicable for reactors or whether portions of it would be, and I guess -- my sense is 1700 covers our license termination plan, and we have other guidance, but looking at final surveys and dose modeling, I mean do you envision that there will be guidance in here that we should pay attention to and comment on?

MR. NELSON: I'd say yes. Exactly which pieces I'm not sure of. Probably the two that you've mentioned are good ones. Of course, you won't see the real dose modeling piece until, you know, next year, but the survey module is -- if you're familiar with Marsum, it's just -- it identifies the various types of surveys, and it references Marsum.

We've tried to not duplicate information in the SRP, use other standing documents, and refer you to those, rather than pull stuff in and make the SRP even larger than it already is.

Yes, sir.

MR. WHITNEY: Mike Whitney from Maine Yankee, just following up on Paul's comment. I was wondering how this SRP for things like the survey compare to the 1700 and the 4006 stuff for reactors.

MR. NELSON: I'd say that they probably get into more detail than -- I'm not as familiar with 1700 as I am 4006, but clearly, it provides a lot more detail than 4006 does, and it's intended to be that way, and I suspect it probably provides more detail than 1700.

If you don't remember to pick up a copy, it's on our web-site, and the web-site's also identified on here, as well.

While I have the floor, I'm going to put in a plug for another topic. If you've been following us on the -- our work on the clearance rule-making, we are in the very preliminary stages of a rule-making to establish clearance levels for residual radioactivity and equipment and materials.

We're going to have our first workshop on that topic on August 4th and 5th in Chicago. We have just published an issues paper. It's now on our external web-site. It just went up today, I think. So, we encourage you to pull that down and read it over.

That's going to form the basis for our discussions at the workshops. Also, we're going to put out a administrative letter, which will forward the issues paper to the licensees, and also have a Federal Register notice out by late next week.

So, if you're interested in that topic, I encourage you to take a look at that issues paper and come to our workshops.

The other workshops will be in San Francisco and Atlanta, and if you're interested in those dates, I can get them for you, and then our final one will be here in November.

Any questions on that?

MR. NICHOLSON: Thank you very much, Bob.

MR. NELSON: Thank you.

MR. NICHOLSON: Really appreciate it.

Okay.

What we plan to do this afternoon is -- the people who gave the talks, the presentations this morning, are at the table, and we would like to go through a series of discussions.

It's called group number five, and you have in your program, at the end, if you look at discussion group five on page -- let's see -- it's on page six. Dr. Ralph Cady will lead this presentation.

We'll spend about 45 minutes or so going over these questions and asking the speakers and people in the audience if they could give us some insights into these questions dealing with ground water modeling related dose assessments in which we looked at real case examples using things like TRACR3D or other codes to look at detailed ground water flow and transport and putting into dose concentration.

Then the other thing we're going to do is, after the break, we'll then call on Henry Morton to say a few words, and then we're going to go through the remainder of the questions that we weren't able to cover in sessions one and three.

So, that's the game plan, and we hope that, by the end of the break, we'll have all the documents, all the hand-outs out on the table, and hopefully then we can adjourn as planned for at five o'clock.

So, I'll turn it over to Dr. Cady.

MR. WHITNEY: Would you be willing to entertain a question before you start? I was just wondering if it would be possible to put the answers to these questions in context, perhaps in two ways.

One, how would the answer be interpreted by a licensee who's trying to decommission today, using the tools available today, and second, what part of your question is more of theoretical, we should do more work in the future, so that we understand, you know -- we're able to put your answers in context in a usable way.

DR. CADY: Okay. In order to do that sort of thing, the sort of tools that are being used today are RESRAD and MEPAS. So, do I have that luxury? I hate to disappoint these fine people.

MR. NICHOLSON: I think what we will do is we will let the speakers try to answer the questions to the best of their ability, and then I think Ralph can call on people like Gene Whelan and Walt Bayelen and other people to also bring the issue back to home with regard to what we consider the more conventional dose assessment codes, but we will try to give that perspective in our answers, if possible.

MR. WHITNEY: Thank you.

MR. NICHOLSON: Okay.

DR. CADY: Okay. I'll start out probably with Sam, because his -- the TRACR3D stuff sounds, to me, relatively new. Is that correct? With the chemistry, the more sophisticated chemistry in there. Has all that stuff been benchmarked and so on and so forth?

MR. LEE: Okay.

You want to see, particularly for number one, what kind of testing is appropriate for the ground water model using dose assessment, and for this kind of problem, first one, it seems to me I remembered yesterday that is -- Carol, EPRI, was talking about based on DandD and RESRA, and she identified some of the key parameters in the ground water model, and so, in that case, I'd like to continue based on TRACR3D, can we identify the same kind of key parameters used for the -- just like she identified.

I think that's probably very useful to try to identify similar -- or identify the parameter used for the dose models, and I think that is very crucial to see which parameter is important, and the second question is -- I don't know -- do you want me to answer all the questions?

DR. CADY: No, just question number one.

MR. LEE: Okay. I think that's it.

DR. CADY: I got from your response that you sort of expect these people, the licensees, the users of these codes, to be doing this sort of benchmarking or testing. Is that a correct interpretation of your response?

MR. LEE: I think so. Probably TRACR3D, at this moment, I think is one test that our ground water model -- we can use that as a benchmark testing, that's true.

DR. CADY: Okay.

How about Ken? Can you address --

MR. RENFELDT: Yeah. I guess I'll come at this from a different perspective.

When I think of, you know, pedigree or benchmarking, what I'm thinking of in my mind is that the code is doing what you expect it to do, and my expectation is that that would not be the licensee's responsibility, that if RESRAD is being proposed as the tool, that somebody has already checked and compared its ground water predictions against analytic solutions that are appropriate, same assumptions, and show that, in fact, it does what you're asking it to do.

Now, you can argue whether the assumptions are appropriate in the model or whether they go far enough or they're too restrictive, but as far as just testing or benchmarking, at least from my perspective, just demonstrating that it's operating properly, and that should be the code developer's responsibility.

DR. CADY: Okay. In the case of the code that you selected for the NTS work, there's a clear history. Not only have you used it before, but there also has been an established pedigree in some fashion.

MR. RENFELDT: One of the restrictions we placed on any code that we use is that there is a long history and a pedigree. SWIFT has gone through many generations of testing against analytic problems. So, we won't use a code that hasn't been through a careful documentation, testing process.

DR. CADY: Okay. Let's say, for your site, you want to have something tweaked in that code. Towards the end of the question, what sort of criteria would you use to establish this pedigree? Is there something that comes to mind?

MR. RENFELDT: Well, if you're going to go in and modify a code, then at the very least, you have to go back and run the test problems that have previously been run to show that any modifications made don't change the outcome, and then, if you've added a particular feature, then you'll want to test that feature against some other benchmark, typically an analytic solution, but if that's not available, then you could go against another numerical code that has previously been benchmarked.

But any time you make a change to a code, you really do need to go check that you haven't inadvertently changed something else.

DR. CADY: Okay. I may take this question and interpret it a little bit different from Barbara.

I assume that HSI GEOTRANS is working for you. Is that correct?

MS. DESHLER: Yeah.

DR. CADY: Well, I'm trying to put a different hat on you, then, or at least put a hat. Somehow you are relying on a pedigree, I would guess. Since I don't know what your role has been in this, I'm putting the hat of being the contractor and them being the subs.

So, you've got some sort of an established -- if you wish to play that role, then not only is the code benchmarked, pedigreed, but the contractor is -- also has a pedigree of some sort, and certainly, GEOTRANS has been around for a number of years, and has an established pedigree.

What sort of things do you look for as meeting these criteria?*

MS. DESHLER: Well, I think you had a good point there about the pedigree of the contractor, because that's why they're on the team. Their reputation was one of the reasons we got the contract. So, that's a good beginning point.

The entire project has a huge review process. Ken talked about the internal and external peers. There's also a technical working group with experts from the national laboratories and USGS.

So, there's a constant process, not just for this model but for everything that's done on the project, and a lot of feedback on whether or not we're doing the right thing. Certainly, none of those people are shy about letting us know.

DR. CADY: Oh, yes. I mean I know that, in the models that I've used, you can certainly misuse a model quite easily. So, the modeler's pedigree is critical, also.

MS. DESHLER: Right. There isn't any such thing on this project as a modeler being able to do some kind of review and get away with it, because there are enough other people.

DR. CADY: Okay. Good.

MR. LEE: And another thing I'd like to point out to the audience -- for example, at the Fernald site, we did have another -- a contractor who used another kind of model, called a 13DF, and I did compare with -- those model with the 13DF model result and the TRACR3D result, and we did a very good comparison, very similar result.

The only thing the 13DF cannot tackle is the unsaturated zone. They only treated a waterfall only at this point. So, even we get a very good agreement between the model result, but the model itself, the TRACR3D, is a little bit more superior than the 13DF, but my point is, at a particular site, we shouldn't be restricted to only one model.

If we can have more models to do the same type of thing, that is more appropriate to see which model is really doing a good and better job.

DR. CADY: Okay. Thank you.

Manuel, would you care to address this question relative to --

MR. GNANAPRAGASAM: Right.

DR. CADY: How about RESRAD off-site?

MR. GNANAPRAGASAM: Okay. RESRAD off-site is still in test mode, so it has not been verified against anything else.

DR. CADY: Okay. Could you address the steps that you're going through?

MR. GNANAPRAGASAM: Well, typically, verification, we don't do it ourselves, because we need somebody who is not already involved in it to do it. So, when the time comes to do it, we contract it out to somebody else over whom we have no influence, so that they can test it out and see if it is wrong and it is right.

So, that's what happened with RESRAD, it was given out to somebody else, and they compared our results against the other independent results, hand calculations, singular models, whatever, and when there were discrepancies, they came back to us and said, okay, how do you explain this, and they had to say, well, you did the wrong thing or there was something wrong with our model and change it.

I think, for RESRAD off-site, that's still some ways off, it's not going to be happening right now.

DR. CADY: Okay. Can you give our colleagues some sense for when that will be completed?

MR. GNANAPRAGASAM: I really don't know.

DR. CADY: Okay. Do you care to address RESRAD on-site as far as the ground water model?

MR. GNANAPRAGASAM: Yes. As I said, that was benchmarked -- verified. It was verified, I think, three or four years ago. I'm not sure of the exact time. They checked to see that we were doing what we said we were doing, not necessarily whether it was right or wrong, just to see whether our coding was doing exactly what we said we were trying to do, and I think that's all verification is. It's not saying right or wrong.

And we have done a fair amount of benchmarking, and all that said is we are doing the same thing that somebody else is doing, again not whether we are right or wrong.

I think that's a caveat that applies to everybody. We can compare models and say this or that, but it doesn't say that we are right or wrong.

DR. CADY: Okay.

Gene, would you care to address MEPAS?

MR. WHELAN: Gene Whelan.

MEPAS -- we have a certain protocol that we follow with

MEPAS. The first thing we do is we develop a requirements document which states exactly what the model or system is going to do. Then we have a design document that we develop that identifies exactly how this system is going to meet the requirements, and then we develop a specifications document which states exactly how we're going to meet the design, and then if we have to develop a new code or make modifications to a code, for example, those modifications are implemented based on those three documents.

We then go through a detailed testing procedure by the people that do the development.

That's then turned over to independent people in our lab, who had nothing to do with the development, and they go through a testing procedure themselves, and as Manuel noted, they usually come back and say you did not meet this requirement or you say it can do this and it doesn't do this or there is some sort of discrepancy and that has to be worked out, and all of that now gets documented.

We also go through a benchmarking procedure with other codes or similar code or results that have been published in the literature by other codes that are similar.

It's fairly extensive, to a certain degree, very much like some of these other models.

DR. CADY: Okay. So, the testing procedure with outside folks, the lab, that's iterative?

MR. WHELAN: We actually use people within the lab but who -- people who are not associated at all with the development of the software or the development of the requirements, design, or specifications.

DR. CADY: Okay. If I find a problem, if I'm one of those testers, I find a problem, I annotate it, send it back to you, you tweak the code, do you send it back to me for final testing?

MR. WHELAN: Yeah. If you were one of the testers, yes, we would send it back to you to see if it met with your approval, that is correct.

So, that is -- and we have put together that particular protocol we started last year in terms of -- because of the frames-type work that we were doing with multiple models, etcetera, and it seems to be working very, very well.

DR. CADY: Okay. Good. Thanks.

Walt?

MR. BAYELEN: Walt Bayelen, Sandia Labs.

For the DandD code, we do have in place a QA program that includes a document of requirements, definition, test plan, specification of test problems, and documentation and execution of those tests and also a version control for the code and a mechanism for notifying users of updates and capturing any problems that they identify with the code and then notifying them of modifications to the code that might result from that.

I'm interpreting, I think, question one as being primarily a QA issue, and as far as just the thoughts on what level of pedigree or benchmarking are appropriate, again, that seems an NRC policy decision to some extent, but it seems that a version control is perhaps a critical part of that, so that it's possible to identify the specific code that was used to do a specific calculation.

So, it would seem that that would be a minimal requirement.

DR. CADY: Okay.

In yesterday's session, I mentioned something about Shlomo's un-ease with codes that don't provide sort of concentration at a certain point or whatever, and DandD certainly does not spit that sort of stuff out so that he could get that ease for concentrations in ground water at -- within, let's say, the aquifer, if we want to call this bucket an aquifer.

In your testing, was that sort of stuff done internally? Because as a user, I don't see that stuff, and I really can't see it, so I can't test it.

MR. BAYELEN: I guess, as a software question, it seems to me the critical question is does the code implement the equations that are claimed to be implemented, and I guess the sort of validation question is a very interesting question but perhaps a separate question, do the equations that you have implemented, in fact, reflect the system in a way that's appropriate for the decision you're trying to reach?

So, there are no recommended calibration procedures, for instance, with the DandD code, as its intention is not to reproduce ground water concentration.

DR. CADY: Okay. Thanks.

Is that the sort of response that you were looking for from the user codes? Okay.

MR. THAGGARD: I think it gets back to, again, justifying the model for your particular site. Obviously, one model is probably more representative of your site than the other, and so, from our perspective, I think we would be mainly interested that the code that you use has the proper pedigree.

So, obviously, if you're developing some new code, then you're going to have to make sure -- we're going to have to have some confidence in that code, but assuming that it has the proper pedigree, then the question is does the models in that code represent -- appropriately represent your site, and so, it gets more into, you know, justifying the code versus your particular site, the features of your site.

MR. EID: I would like to add to this, too. It is -- the difference is not just only the model. The differences also will be in the input parameters for the model. It depends on what kind of parameters you have.

One of the reasons that we find differences between DandD and RESRAD is because of the input parameters. The approach for DandD, for example, takes -- it force the code to select certain parameters, and if you look at those parameters, you will find they are very highly conservative. If you go to RESRAD, then you input the same parameters.

So, these great differences that we saw yesterday will be minimized drastically, and the difference will be not as great as we think.

So, the parameters, they are so important, and these differences that you find maybe is not, indeed, in the model, maybe, indeed, in the input parameters. That's one thing you need to be sure about.

If DandD conceptual model does not fit your site, there is no reason to use DandD code; you could use other codes.

Also, we'll entertain using -- for site-specific analysis, we will entertain using any code that you select, but you need to defend, of course, use of the code, the conceptual model of the code, is it compatible with your site and the input parameters that you have, are they compatible with your site-specific conditions.

MR. MEYER: I can make a further comment there. From a modeler's perspective, if I was running one of those or both of those models and got different results, the thing to do, the approach to take, is to ask yourself why the models are producing different results.

Is it because of the implementation, is it because you use different parameters or the parameters are represented differently?

If you can't explain the difference, then you're in trouble, but if you can explain the difference, then you can resolve the difference. But in order to get to that explanation, you have to be able to understand how the models are making their calculations and what exactly they represent.

MS. POTTORFF: Elizabeth Pottorff, State of Colorado.

Coming at this from being a ground water modeler, you actually need to be able to defend your model in a legal sense should it ever go to court.

Every single part of that code should be defensible and documented and tested. Otherwise, you could be, you know, up the creek without a paddle with your estimates.

DR. CADY: Thank you.

Gene.

MR. WHELAN: Gene Whelan.

I'll just note that I've been involved in a number of benchmarkings, and I know Emmanuel has, too, and some of the other people here, and one thing that we recognize in these benchmarkings is we can input to the models all the same data, we can look at the formulations and think that all these models are the same, but what we find out is that they end up with different results, because the modelers themselves, when they wrote the code, inherently build into the code the things that they feel are representative of what the model should do, and many times, that's not included in the documentation.

So, it doesn't surprise me at all that you could take two separate codes with the same mathematical formulations, which I've done, and run them and get two different results, several orders of magnitude difference, and then when we went in to ask the question, as Phil noted, why, it was because the model developers had inherently put in some of the things that they wanted to see or have that code do, thinking that everybody else was doing it, too, and in fact, people did it differently.

So, if you get different results, I would seriously consider asking the question, why am I getting different results?

DR. CADY: But if Gene Whelan wasn't out of breath, he'd probably also say does it make a difference in your final decision?

All right.

We already talked about unnecessary conservatism or inappropriate optimism yesterday, I believe, but there may be some elements of the ground water model that, as Gene alluded to, there's stuff that's hidden within these models that may introduce or contribute to inappropriate either conservatism or optimism.

How about our panel?

Ken?

MR. RENFELDT: This is particularly difficult, I think.

One of the approaches that we're using on the NTS is to bring people in like Shlomo Neuman, look at our models, not at the coding, necessarily, but at the kinds of assumptions we make to implement the models, and ask them, as our external peer reviewers, does that make sense to you?

Sometimes it's very easy to get caught up in the modeling process and begin to make assumptions so that you can make progress, and it's always helpful to have somebody coming in behind you, looking at those.

So, that's, in part, one approach that we've used, and also, I think, as someone else mentioned, some of the questions of whether the conservatism is unnecessary or inappropriate comes from the regulators. It may not necessarily be a modeler's decision.

DR. CADY: Okay. You also mentioned that you're only dealing at this point with the saturated zone.

MR. RENFELDT: Yes.

DR. CADY: You've made a fairly explicit statement that this is what you're ignoring and you have a logic and a rationale for doing that.

MR. RENFELDT: Yes.

DR. CADY: Sam, how about at Fernald?

MR. LEE: Yes. Based on my talk, I did very clearly mention that the simplification of the Kd, in this moment, that most people use an equilibrium assumption, and so, that is -- we have to carefully -- that kind of simplification is appropriate or not. It depends on the site.

If the site is very complicated, involving chemical precipitate species, then the classical simplification or the Kd, equilibrium assumption may not be appropriate.

So, that is -- we have to carefully to see that -- what kind of approaches we are dealing with, and it depends on the site, and so, at this point, we have to justify how complicated of a site and what kind of species we are dealing with.

MR. NICHOLSON: Sam, when you made your presentation, I thought it was fascinating. You were looking at 40 years of record. You were looking at actual monitoring data to some extent. Is that correct? To compare these simulations?

What kinds of insights do you have with regard -- to determine what was appropriate?

I mean do you want to look at a site in great complexity, or do you want to try to simplify, and then how do you determine, based upon your comparison with monitored data, whether that simplification or going into greater complexity is warranted?

MR. LEE: At this point, for the Fernald site, we've found that we have to use complexity as our model in order to really identify that decommissioning, how many years later we can clean the site.

Based on the equilibrium assumption, we have to take forever to clean the site. So, in that case, based on the non-equilibrium assumption case, and we can see that within 15 years, probably, we can clean the site, and so, that kind of approach, we had to know ahead of time to meet the criteria, the cost, how much we have to spend to clean the site.

DR. CADY: Okay. So, that moves us into question number three.

MR. LEE: That's correct.

DR. CADY: You've got a few years of record, I assume, of operations at Fernald.

MR. LEE: That's right. Question three -- that is what kind of independent data we have to have. So, that's why it seems to me we have to -- additional data to identify if chemisorption is important or not.

If it is important, then we can see that the non-equilibrium assumption is appropriate for the site. So, that's why I think that is, even for this moment, the data we have is still not good enough.

We should have continued to monitor that data we have in order to identify how important is chemisorption at the site.

DR. CADY: So, am I correct in assuming that they are pumping currently at Fernald?

MR. LEE: That's correct. They continue pumping the -- at the site, and they continue to -- based on the model result, they'd like to identify where we have to drill, how deep we have to have and how many wells we have to have in order to continue pump and inject back to the well.

So, that is -- we both continued doing the modeling study and the decommissioning remediation, and both continue to do the back-and-forth engineering to see, okay, this is a place we have to drill another well in order to stop the plume continue to move forward, that kind of stuff, that's right.

MR. BIRKLAND: Rich Birkland, Siemens.

I'm a health physicist, and I deal more with dose to people than I do with environmental-type things, but -- and realize we have a bunch of modelers here, but to me, if you use a model and you expect it to predict the right answer, I'd be real skeptical of that.

You take any one of these internal-type doses and people will differ from that remarkably, and I would suspect that none of these codes are really going to work. So, I don't know exactly how you verify them.

What you're doing is giving your best estimate.

MR. LEE: Yeah, but in order to answer that, we have to continually compare our model result with measurement data. That's why we request at the site for the engineering to continue to get new data, and then we can compare with our model result and how this model is doing. I did not show that comparison in my talk, but I did some comparison with the model result with the measurement, and a certain site, certain location, we did a very good job for the modeling comparisons.

DR. CADY: Walt.

MR. BAYELEN: Walt Bayelen, Sandia Labs.

I'd like to just suggest that, in general, the answer to question three is no in that you cannot collect data to confirm a particular ground water model. I mean it's an endless process. There's no way that a specific ground water model, I think, could be confirmed to some arbitrary degree.

So, it seems it's more a question of dis-confirming alternative models.

So, the question is, is there a viable alternative to the calculation you're doing that causes you to reach a different decision, and if the answer to that question is yes, then you can ask the specific question, what data would allow me to distinguish one model from another, but as far as pursuing a confirmation of a specific model, that problem will not stop.

I mean there's no stopping condition for confirmation of a single model in general unless there's a specific alternative that leads to a different regulatory decision.

DR. CADY: Okay.

Gene, do you want to address that? No. Okay.

Well, we've nailed one, two, and three, unless the licensing colleagues have anything to add.

MR. THAGGARD: I would just like to point out that, strictly from a ground water standpoint, if we're only looking at the ground water analysis, I think there's certainly some data that could be collected to confirm the ground water analysis.

If you're talking about doing a ground water flow analysis, there's a lot of work that's been done in terms of validating ground water flow models.

If we look at that question from the standpoint -- only from a ground water standpoint, I think the answer would be yes.

When you start taking it into the realm of doing dose analysis, especially when you're talking about dose analysis way out in the future, then the answer is probably no.

So, I think it depends a little bit upon how you ask the question and what timeframe you're looking at.

MR. EID: I would like to add that I think, when you answer this question about validation of the ground water model, you need to ask a question about the purpose of that model.

If you know in advance that the purpose of that model is for screening, you should not expect that the results will be always, you know, realistic, could be some conservatism, but then the question is how much conservatism in that specific model to serve the purpose.

If you find it's excessively conservative for your purpose, this means you need to think about other alternatives, and also, we need to think about these models, to look at the dose.

You do not look specifically at the ground water model when you use the dose in terms of the health physicist and in terms of compliance with the regulations.

That is why you need to -- also to think about what is embedded in them model, also, variability of the sites.

So, for screening models, variability of the sites plays a significant role in what you select and what kind of parameter is selected for that specific model, and they will, of course, impact the results of that specific model.

MR. WIERENGA: This is Pete Wierenga, University of Arizona.

Maybe I didn't understand Walt's response completely correct, but I thought that he said that independent data should not be collected to confirm ground water modeling.

Is that what you said, Walt?

MR. BAYELEN: Walt Bayelen, Sandia Labs.

Yeah, I guess I was saying that, in general, the answer to that question cannot be yes, because it -- I guess for two reasons.

There has to be some stopping condition, some sufficiency condition, because the process of modeling confirmation can just go on forever, and I guess the second argument was that it is not possible to uniquely confirm a specific model, that the question of model confirmation is really disproving a propose alternative, and so, it seems a more important question is not confirming ground water modeling but dis-confirming, if you will, an alternative ground water model.

So, it's not that -- I didn't mean to suggest that it's never necessary to collect data for a ground water model, but the general answer to do we need more data cannot be, in general, yes. There's no way of terminating the data collection process.

MR. WIERENGA: That seems to me somewhat of a vague answer.

I would, to some extent, disagree with that, because no matter whether it's for a specific model or for a group of models, as we heard before, in many cases these models are used in the courtroom and in other situations where you deal with stakeholders, and it's my experience that stakeholders, people in the courtroom generally do not have that much confidence in a model or a group of models if it hasn't been tested in a real situation, field situation, and backed up with actual data, and it's also my feeling that we have a great deal of models, not just the ones that you're talking about, also the ground water models, etcetera, and very few have been tested in the field under adequate and controlled conditions, and there is a great deal of room for improvement of adequately testing models before we use them in situations of predicting, let's say, long-term or short-term events, and so, in general, Walt, I would think my answer to that question is yes, you need independent data to confirm, test ground water modeling, in general.

MR. RENFELDT: If I could interject something here, also, we've worried about this a great deal at NTS, and I agree with Walt, you can never verify a model deterministically, for example, and I don't know if you recall, but my last slide was model acceptability, which means that we will go through a process to determine amongst ourselves, with our regulator, etcetera, whether the predictions are acceptable to them or whether we have given them enough confidence to accept our results. That doesn't mean we're asking them to say the model is true, it's verified. It's does the appropriate stakeholders agree that this is acceptable.

One method that we have thought about -- in our predictions, we include what you've talked about as a mean case or an expected case and then a range of variability. We intend, I think, that we're going to have to go out and collect some additional data after the modeling.

One way to do that is to collect information, either key model assumptions, such as conductivities were supposed to be within this range or hydraulic gradients are supposed to be in some range somewhere else, we have a range of predictions, we go in and we collect data, and before we collect that data, we go in and sit down with our regulators and say I said conductivity is going to be between one and four, and you've seen my predictions at one and four, if those are acceptable and I go in and measure a value of three, we're okay. If I go in and measure a value of 10, I'm outside of my range, and we would reconsider what I'm doing.

So, I don't ever verify to a particular value, but if I've bounded my calculations and then can show by appropriate data collection that data points fall within the bounding range, I get greater confidence.

At some point, it becomes a negotiation. It is iterative, and you end up negotiating with the regulator or whoever to say, you know, when am I going to have enough data? I've shown you six times now that I fall within my predicted range. How many more times do I have to prove it to you?

But you'll never prove to anybody that I can tell you the concentration 75 feet away. I can bound it for you, if that bound is acceptable.

MR. EISENBERG: This is Norman Eisenberg from NRC.

First of all, I want to, with all due respect, take issue with Walt Bayelen.

The NRC staff has spent a lot of time thinking about the issue of how much confidence is needed in modeling and how you go about achieving it, and I think our approach would be very pragmatic, and although I think what Walt said, in an absolute sense, is true -- that is, no scientific theory can ever be proven, all we can ever do with scientific theories is disprove them, and you get more confidence in a scientific theory if you disprove alternatives, that's not necessarily a real practical way to approach things here.

We have written a recently published NUREG with the Swedish regulator, SKI, on confidence building in performance assessment models and approaches to it, and that tends to also be very pragmatic.

There are really two issues here, I think.

One is should you use additional data to help confirm the validity of ground water predictions, and it depends, of course.

If you have a very simple situations and you use demonstrably bounding or conservative estimates, then you probably don't need to do that.

If you have a very complex situation and you're close to the regulatory limit, additional information that helps build confidence in the result that you have obtained is, of course, useful, and I don't think, for example, in the case of Fernald, that if you could use the model to predict what has happened so far as a way to confirm your predictions for the future -- that would be a good thing to do.

That would help give confidence that the regulator needs that you should proceed on that course.

The separate question is, at a particular stage, do you need to go out and get this additional data with the corresponding expenses, is a much tougher issue, and I'm not sure -- you know, that would have to be decided on a case-by-case basis.

But I guess my bottom line is I don't see the NRC staff rejecting this kind of information. In fact, I think we would welcome it, but I'm not sure that we would demand that it be obtained.

MR. LEE: But another comment -- more data is better for modeling, no matter what. If you can use that data, additional data, and it’s good for the validation or good for the input, the model.

So, I always encourage to have additional data, even independent of any other kind of data. I think that always is useful from the model point of view.

MR. NICHOLSON: If I could make a comment on that, we were involved in an international project called InterVal, and your comments are appropriate if the data is extremely relevant.

We had test cases in InterVal in which there was a tremendous amount of data collected, and during the course of it, even more data was collected, and unfortunately, people became confused, and there was so much information you really lost the point of what was going on.

So, when you collect the data, it has to be focused on what your objective is and what those relevant parameters are.

You can use -- as Dr. Neuman said the other day, you can use many different models or even the same model with different interpretations to come out with the same results.

If you collect tons of data, it doesn’t necessarily narrow it unless the data is collected using a special design to help do the comparison that Walt Bayelen discussed or to develop the confidence that Norm is trying to elaborate on.

So, I don’t think more data is necessarily correct, but a focused confirmation program in which that data helps to develop confidence is extremely valuable.

MR. LEE: Yes, I totally agree with you. That’s right, yes. I pointed that out in the talk. Specifically for the chemisorption, we like to have that from the model to know which specific data we want to collect.

MR. GEE: Glendon Gee, PN&L.

I think there's a danger in the plug-and-play modeling that we've heard about the last two days, and that is, since there are readily available surrogate data, to simply grab it and use it, and that danger leads people to surprises, and the ground water often is full of surprises, and the case in point is observations at Hanford, where contamination of cesium was deeper than expected and led to wild conclusions that the french fries growing along the river would be contaminated with cesium in future generations because somebody found cesium at 120 feet when it should have been -- if they had used the available data sets in predicting cesium distribution coefficients, Kd's, of any kind of normal expectancy, if you had used PDFs or other kinds of distribution and picked the most extreme, you would still not have predicted the observed cesium distributions, and so, all the plug-and-play models, all of the screening models, all of the models that were used in the EIS statements for the waste remediation under-predicted the cesium distributions, and it was largely because there were not data, site-specific data for the cesium.

There are other stories. It turns out that, with some additional geo-chemistry, that it's a unique situation and that the cesium actually is tightly bound, and it isn't going to course through the ground water to the river and end up in your McDonald french fries.

I don't think that's the answer, but it led people to look a little more carefully at processes and other things that put the cesium where it was, and there were a number of reasons for that. It's still being sorted out.

But I think to -- the tendency is to take default parameters and use them simply because either we're too lazy or we're not sensitive to the site-specific issues, and it's often that maybe a combination of both, but the readily available plug-and-play models tend to allow you to go to these default parameters, which often are not reflecting the site-specific physical chemical processes that are actually moving the contaminants through the ground water, and I think that's the danger, and I think that's the reason that you have to have -- maybe NRC shouldn't specify the number of data points or when to stop collecting data, but it should at least require the licensee or whoever else is collecting the data to justify the use of the default numbers.

I think that's one of the issues that ought to be emphasized repeatedly.

MR. EID: I would like to add to this, you are absolutely right.

I will assure that that's what we'll be looking at, is the rationale for selection of the parameters, and we do not assume that the licensee will use a code and input directly whatever the parameters there without looking at their site-specific conditions.

We have two cases.

A screening case, we do assume, you know, some assumption, conservatism in the code, so we will not look at the parameters for screening cases. That's why I would like to see if somebody comes to us and say the current code is not substantially conservative in certain cases, would like to let us know about it.

For the site-specific cases, definitely we will not accept just the parameters to be input, you know, based on the default unless they are explained, unless they are justified.

MR. HAMDEN: It seems to me, you know, everybody here must realize the lack of confidence or the uncertainties that we have with models, and that's clear, everybody knows that, and what's puzzling to me is that nobody is making a distinction between new sites and sites that are already contaminated.

With new sites, it's appropriate and, in fact, necessary to use models, because it’s the only tool that we know at this time, like performance assessment of the high-level waste program, for example.

But for contaminated sites, why are we so much into models? The standard involves a point of compliance and a concentration in the ground water.

It is a ground water standard, yes, but nothing’s wrong with it, because in this way we avoid all these uncertainties about models, and if you don’t like the compliance at the more difficult sites, the problematic sites, you can move your point of compliance further, but still, it’s a point of compliance, it’s a concentration of ground water, and you have to deal with the uncertainties that you have with models.

In decommissioning, I find surprising that, at decommissioning sites, which, by definition, are already contaminated, you are so much into modeling.

MR. LEE: Can I just comment on this question?

At the Fernald site, for example, we are using a pump-and-treat. So, in that case, we have to know how much pumping rate we’d like to have.

So, in order to answer that, we have to use a model to determine what kind of pumping rate we use in order to meet the criteria to pump, the actual pumping rate.

So, that is the way we have to use model. It doesn’t mean that, if it’s contaminated there, we don’t use model.

So, that, it seems to me, is not the way to avoid the model. It depends on the site. In the model, we do have the pumping rate to be input as a very important parameter to determine where and how much -- how many wells we have to use in the model.

So, those things -- we have to consider that. That’s why we have to continually -- during the decommissioning period, we still have continued to use our model to do the things we want.

MR. HAMDEN: Sam, I grant you that, but that's a very limited use of models, and what we have been hearing today, the uncertainty about models, you know, about another aspect of modeling, the prediction and what's going to happen, the dose in the future, and whether it will meet the standard or not.

It's not so much, you know, the things that you mentioned. That's fine. That's justified and fine, but what we are talking about is the dose and meeting the dose standard at these sites. That's the problem, right here.

DR. CADY: I think we've beaten this to death.

Henry, do you have something you'd like to present? And then we can continue with this after the break.

MR. MORTON: My comments, I think, will be fairly brief and will deal with the implementation.

Basically, we've just had a good discussion, in general, that relates to the first question, and after this general discussion, I think this question basically boils down to one of essentially then asking, in essence, what will be the Standard Review Plan for acceptability of an alternate model and the application of that alternate model in a particular site-specific case.

The second point basically is that -- the point would be that, when we recognize that the user will always be responsible or burdened with showing that the conceptual model, his conceptual model of his site, and the mathematical model are compatible or that the mathematical model represents the conceptual model reasonably well -- given that, it would be helpful, over time, as the agency works these cases, if you could come to recognize or kind of let us know which of the mathematically coded models or programs and models you consider to be generally acceptable given the licensee's burden to show that the conceptual model and the mathematical model are compatible.

Beyond that, something that is perhaps a little bit more functional or housekeeping or mechanical in nature is that, once the ground water modeling is done -- that is, the estimates of the future ground water concentrations -- then we need mechanically to carry this through with the remainder of the pathways analysis to get the dose estimates for all pathways, and there's mechanically some things that are needed there.

First, when we think in terms of RESRAD and DandD as the vehicle for the remaining pathways, we need mechanically a way to be able to enter these predicted or estimated future ground water concentrations and nuclides into those codes so that they can be combined with the remaining pathways, so the total estimates for all pathways can be made.

Now, the good news here is that DandD has been coded in such a way that you can get soil concentrations and can get drinking water -- concentrations from the drinking water pathway, and the question -- and the apparent additional need is to be able to turn or toggle on or off the ground water -- I'm sorry -- the remaining pathways downstream of that point at which we're predicting the concentration, so, for instance, that we aren't necessarily forced to estimate the dose from irrigation water or dose from fish if, indeed, those pathways don't exist downstream of the point at which the alternate ground water model estimates the concentration, and so, I'm not aware that RESRAD will handle this kind of thing, and so, that would be a need for RESRAD to be altered to allow one to input nuclide concentrations in water that are calculated or estimated from some different approach, even if they might be environmental measures and not necessarily predictions from modeling.

Overall, in order to better understand what's going on in the modeling, I think we need to be able to toggle each of the pathways on or off in RESRAD, as we're able to do with -- I'm sorry -- in DandD, as we're able to do with RESRAD, and that would let us be able to study what's going on and learn more of what these models are telling us on a pathway basis and not have to try to unravel them from some kind of sensitivity study that forces us to look at one dose for all pathways, and then, finally, in order to understand what's going on better, DandD, particularly, needs to list, whether it's tabular or graphic, more of the values of intermediate variables so we can see what these models are telling us.

For instance, it would be helpful if DandD would produce for us ground water concentrations or some other intermediate values.

That is the essence of what I had to say. Basically, it's to recognize that licensees, because of existing license commitments or because of the timeliness rule, have these needs now, and they are not a year away, they're not two years away.

So, we need to have the tools now to exercise and to do the decommissioning plans and the analysis to support them.

MR. EID: For the first question, what will be required to gain approval to use a mathematical model for ground water, and the question is what are the other models that you have. It depends on the site-specific conditions, and it depends on the scenario.

If you assume the receptor will be located off-site and you have a large site and you are trying to use, for example, DandD code, we know that this possibly is not applicable and you need to use more advanced model.

So, if you have somebody on-site, maybe RESRAD could be appropriate, but if it is off-site and a large site, it is very clear, we need to use other kind of tool, more advanced tool, like, for example, RESRAD off-site, but it's not well-tested, but it could be another equivalent code.

If there is a code that's specifically designed for off-site analysis -- I do not want to mention now the names, and whereas the analysis should be done for on-site, the farmer scenario, this means you are off the mark, you are not considering, you know, withdrawal directly from the site.

So, you need to assess -- those are the issues I talked about my previous -- in my presentation yesterday. The receptor location is very important, and the scenario should be considered in the ground water modeling.

So, all those together, they have to be accounted for when you decide on what kind of ground water model to be accepted or not.

MR. THAGGARD: I think, as a general rule -- and obviously, I think the Standard Review Plan is going to provide more guidance on this, Henry, to specifically answer this question, but I think as a general rule, I think we've talked about some of this today.

Obviously, it would be helpful if the code has some degree of pedigree. Otherwise, you're going to have to convince us that it's an acceptable code.

So, if, you know, the code has some degree of pedigree, that kind of helps out, and then the other obvious thing is it needs to be appropriate for your particular site, and so, that gets back into the models, the mathematical models being appropriate for the conceptual model at your particular site.

So, it needs to appropriately represent the features and processes at your site, and I don't mean to be vague about this, but that's the bottom line. I mean that's kind of what we've been saying over these two days, I think, here, is that it is important to understand a little bit about the features and processes at your site and understand a little bit about what these codes are doing, and so, other than that, I mean that's all I can say in a general sense for that first bullet.

MR. MORTON: I think this is as much or more than I expected. Since this question was prepared in advance, the good news is that this most recent discussion has really dealt with these issues.

Kind of the thought concept here, in raising the question, is to being this dialogue of what are we looking for, and the general discussion addressed things like pedigree or general industry acceptance, generally recognized as an industry code.

The discussion addressed things such as how much verification are you looking for, what kind of QA package, if it’s an original code that’s not, quote, "industry accepted."

The discussion began to raise the issues, how much benchmarking or how appropriate, how much site-specific information.

These are really kind of the thought processes that I basically wanted to distill in one question here, and the good news is you’ve discussed it in this last session. So, I really don’t expect anything more at this point in terms of an answer, but since it was prepared in advance, it’s the kind of question to trigger the fact that the licensee and the agency will have to entertain these kinds of questions.

MR. ROBERTS: Rick Roberts, Rocky Mountain Irradiation Services.

I’d just like to amplify on one of the points that was just talked about.

In selecting any ground water model, I believe you really have to know and define your receptors.

Now, a lot of work has been talked about about looking at, say, an on-site well for a residential receptor, but there are many cases where that will not apply at a site, and instead of having a dialogue between the licensee and the NRC, is there any way that, in the Standard Review Plan, that the NRC could put in there the types of receptors, not only the residential on-site drinking water well but the other receptors that they would expect to see assessed, if maybe an on-site drinking well were not applicable, things like fence-line doses or ground water to surface water, those types of things, so that we could have a set number of receptors that may be possible for assessment?

MR. EID: This is a very good suggestion.

We are working on that, and we will include in the SRP modification of the pathways and modification of possibly all the scenarios, the possible conditions that we are quite sure about, and of course, this will be related to the receptor location, and this should be included in the SRP.

I do not promise that we will go into depth or detail to address every specific case, but we will try to include as much as we can that we believe could be legal and also is acceptable, and we have some background to justify what we are saying.

MR. ROBERTS: Thank you.

MR. MORTON: Isn't it going to also be the case that the licensee or the site owner will have some opportunity and some burden to define what it thinks are reasonable receptors and justify why others are not?

MR. NICHOLSON: Chris Daly from the Office of Research.

MR. DALY: I just want to make a couple of clarifications on some of Henry's point and the question that came up there.

In the statements of consideration for the rule-making for decommissioning, it's mentioned that you need to look at the critical group, and there's no distinction between they have to be on-site or they have to be off-site.

So, if your critical group is off-site, you have to use a tool that's appropriate for estimating dose to that group.

A couple of things on your slides, Henry.

We make statements in Draft Guide 4006 and several times in 1549 that DandD is not required to be used. It’s offered as an option, and there’s also a requirement in 1549, a list of requirements for what you have to demonstrate in order to use DandD.

MS. DALY: Have you looked at one of the output files for D&D that gives you intermediate concentrations and other information at each time step?

MR. MORTON: Yes.

MS. DALY: And you need more information than that?

MR. MORTON: Yes.

MS. DALY: What additional information would that be?

MR. MORTON: I don’t know that I can define all the things I’d be interested in right now, but basically when I’ve used D&D and, separately, when I’ve used RESRAD, work through a problem and one may look at the information you have and wonder what is responsible for the dose from this nuclide being prominently more from that nuclide, and do I understand what’s going on here or do I understand what this model is doing to have produced those differences that I may or may not have expected.

So what I want to do is work back through the intermediate calculations, the intermediate output, to see if I can tell what it is. And going back, historically, sometimes you’ll say, well, that looks like it must be due to concentration factor, a transfer factor. It might be due to some change in the intake-to-dose factors and this recent set that was not reflective of the last time. It might be due to the waiver, maybe -- maybe we or this code is interpreting whether Kd is -- whether the Kd values are different, or it might be that issue of in the way this is functioning, is the leachability governing or being overridden by whatever this value of Kd is and the way this thing is coded.

The more output we can get, intermediate values, the better we can study our case and try to understand then whether or not these programs are really the right ones for our site.

MS. DALY: I guess I'm still a little confused, because we provide information for each calculational time step, radionuclide-specific, and by pathway. So that's a fair amount of information that you have there in terms of intermediate results.

MR. THAGGARD: Is that in the FORTRAN output file you're talking about, Chris?

MS. DALY: No. It's the report that you can toggle on and off when you first execute --

MR. THAGGARD: The summary report or the FORTRAN report?

MS. DALY: Neither one. There's a third report.

MR. THAGGARD: Okay.

MS. DALY: When you first start the code, there is an option for toggling on and off, if you want to keep the intermediate results, basically. And since it's such a massive file, it's defaulted to not being checked.

But you can check it, and volume two, which has now been published, fortunately, does explain these different functions and the format for that file.

The other thing is all of the equations that we're using and how they're put together are available and, on request, the testing that has been done is available. So I guess if you could be as specific as possible, if you want to think about it and get back to us, that would be very helpful.

MR. THAGGARD: Okay. Sure.

MR. NICHOLSON: We really appreciate your answering questions. And as with anyone here, if you have more information or suggestions, contact the staff.

MS. DALY: Unfortunately, I still have some comments to make on his second slide that we hadn't gotten to.

MR. NICHOLSON: Okay. I'm sorry, Chris. I thought you were done. Go ahead.

MR. MORTON: Sure. Okay.

MS. DALY: Your second slide.

MR. MORTON: I'm sorry. Okay.

MS. DALY: You can toggle pathways on and off in D&D. It's not a simple check box. You have to do it by pieces. But you are able to do that, so you're not forced to always calculate dose from all pathways.

MR. MORTON: It seems to become by blocks.

MS. DALY: You have to deal with the parameters that affect that pathway and we left that not as a box to give you more flexibility, because sometimes there's certain inputs to a particular pathway that you want to remove, but the pathway itself is not completely eliminated.

MR. NICHOLSON: Thank you for the clarification. Jack Parrott, from the Office of Nuclear Materials Safety and Safeguards.

MR. PARROTT: That's right. Based on the discussion that Henry and Chris just had, I have a question for Walt Beyeler. I've seen recently that both Argonne National Lab for RESRAD and PNNL for MEPAS are offering workshops, hands-on type of workshops for their codes, for a fee, but they have these workshops. I was wondering if there was anything planned for D&D screen or something like that.

MR. BEYELER: I was just told by Chris that the answer is yes. I'm not sure if I can wait for some elaboration.

MR. EID: I would like to add more.

MR. NICHOLSON: Wait a minute, let Walt finish.

MR. BEYELER: I actually had no more to contribute.

MR. EID: We did request officially the Office of Research to provide training for NRC staff. I think there is a need also for training for licensees, if they can pay for it, on D&D. So I guess we are talking about it and there will be some kind of schedule for the D&D training.

MR. NICHOLSON: We'll let Emmanuel make a comment.

MR. GNANAPRAGASAM: Yes. I was trying to understand the second slide, the first request. You want to be able to input water considerations for each nuclide. Is it at one time or a function of the time? Currently, RESRAD allows you to put water considerations for one time.

MR. MORTON: I think that's one of those that it depends. It depends on what one has really estimated for your case. But if you have a case in which, for instance, the maximum or the peak dose for ground water occurs at a different time from what the time the peak dose occurs from some other pathways, and you may need to make them time dependent.

If, in some other way, you've resolved the time, then maybe you would only need to put in one. But if I were asking for the flexibility --

MR. GNANAPRAGASAM: As a function of time.

MR. MORTON: -- I'd want to be able to put in several time steps or concentrations, several different concentration times.

MR. GNANAPRAGASAM: For water and for everything else or just for water?

MR. MORTON: I think what one has to do is to look at it and say for what other medium intermediate medium might we have data.

One of the things we've never really discussed, for example, in these workshops, that I'm aware of, is the fact that for the external radiation pathway, we seem to be dependent or relying totally on calculations.

We may have a situation in which we can simply go measure it and in that case, it would be helpful to be able to enter exposure rate or some measure of the radiation intensity.

MR. GNANAPRAGASAM: Okay.

MR. NICHOLSON: Walt, you were the next person. We'll go to Tom, and then go back to Walt.

MR. POTTER: Tom Potter. I think I can elaborate. I've actually had a situation where I used measured exposure rates to calculate direct dose and then had to combine that with RESRAD output off-line. It would be nice to be able to do that in the RESRAD framework.

From the standpoint of nuclide concentrations in media, I believe if we could basically run RESRAD by inputting the concentration file, that would be a nice flexibility. The concentration file that RESRAD currently puts out is intermediate output.

MR. NICHOLSON: Walt?

MR. BEYELER: Yes. To return to the question on the training for the D&D code. Just to remind everyone, as we discussed in an earlier workshop, we're currently working on version two of D&D, which will include the Monte Carlo sampling and also the ability to specify initial concentrations in media. So it would seem reasonable to have training on conjunction with the availability of that version of the code.

MR. NICHOLSON: When do you think that will be?

MR. BEYELER: I believe that's scheduled for delivery to NRC in, I believe, October of this year, as a beta to NRC in October of this year.

MR. NICHOLSON: Thank you. Well, I think we've discussed this quite a bit and I really want to thank Henry for coming forward with his suggestion.

What we'll do is we'll take a 15-minute break. Then what we're going to do is we're going to go back, if you have your agendas, there were some questions remaining in discussion group number one and three, we'll go over those, and then we're going to provide an opportunity for people from industry, the states and elsewhere, if you want to make some statements at the end of the meeting, we'll provide you with that opportunity. Then we'll have closing remarks.

So let's break for 15 minutes.

[Recess.]

MR. NICHOLSON: Two bits of clarification before we begin the final home stretch here. There are two outstanding viewgraphs that people haven't gotten yet. One was from Professor Neuman. Those copies are being made and hopefully they will -- they will definitely be done by 4:30, so hopefully they'll be out there.

The other one, that is not available and probably won't be, but we will make sure that it gets into the public record, along with the transcripts, and that will be the ones from Argonne National Lab. I talked to Emmanuel -- he must have just stepped out -- he assured me that we had downloaded -- he had used PowerPoint and we downloaded them. He wasn't happy with the hard copies that came out.

So he has assured me, he has promised me that he will send us a copy and then we will make sure it gets into the public document room.

So those are the only two outstanding ones.

What we're going to do now, I'm calling on Dr. Ralph Cady to go through the remaining questions that weren't fully discussed in work group or discussion number one and number three.

When we get done with that, then we're going to open the floor up and I will call on people, if they want to make any final statements or comments, and then we'll adjourn.

So I will turn it over now to Dr. Cady.

MR. CADY: So I guess the game plan is to read these questions and if nobody is jumping up anxious to answer then, we'll proceed to work our way through.

So for question number three in this first session, the first group discussion, can one use current ground water monitoring data to supplant modeling of future doses. I think that was something initially that Henry had raised a while back, and so we put that in as a question. I'm actually going to call on Gene to see if he's willing to give a response to this.

MR. WHELAN: There are two types of assessments that I generally work with. One is a comparative assessment and one is a predictive assessment.

In a comparative assessment, basically what you do is you identify the situation that you're going to simulate with a given model and then you vary the parameters and then you compare the results.

So in fact, you may not have any monitoring data to work with, but if you have different conditions and different situations, you can see what the ramifications of changing those conditions, what they are relative to one set of results to another.

In a predictive assessment, what we do is we actually try to estimate or predict what might actually occur in the real world and when we do that, what we need to do for our modeling, I believe, is to try to anchor the modeling exercise back to the real world and the way we do this is we use monitored information and with that monitored information, we can go and calibrate the -- in this particular case, the ground water models, such that the predictions we come up with, at least in the timeframe and the location of that monitored data, our models can recreate, to a certain degree, what's happening in the real world.

Again, that goes back to the question of do we have a certain degree or level of confidence in the results from these models. So with respect to this question, I believe if you have monitored information, you should try to factor that into any modeling exercise.

And it's just as important with the complex models or numerical models as it is with the more simplified semi-analytical models.

MR. CADY: Thanks. I think this also has implications to the licensing process.

MR. THAGGARD: Actually, I did want to comment on this particular question. This kind of gets back to the question that Latif Hamdon raised and, unfortunately, he left, in terms of why are we doing this modeling for decommissioning, when we should have data, since most of these sites are contaminated. I think that was his question.

I think you could certainly use ground water data, and you should probably use ground water data, to some extent, to help with your analysis. I think this gets back to what Phil Meyer was saying about being able to do inverse analysis, in terms of being able to determine the appropriate parameters for the analysis.

If you've got that kind of data, you certainly should use it. The problem is you can only use that data to a certain extent. We're doing an analysis out in the future, so that data only can carry you only so far.

You've got to worry about additional contamination occurring from the soil, stuff that hasn't gotten to the ground water yet that may still get there, and the only way to assess that is basically to use models.

So I think the answer to the question is you certainly should use data to the extent you can, but I think they're only going to carry you so far, especially if you've got a source that's still sitting there, where you may have additional contamination occurring in the future.

MR. CADY: Thanks. Yes?

MR. NARDI: Joe Nardi, Westinghouse. As I've mentioned, we have a site where we have ground water contamination and we have monitoring data and followed it since '84. So we actually have quite a bit of data to look at the past of what the concentration in the ground water has been.

But if you try to use that into the future, you run into a couple problems. In the past, we have been doing pump-and-treat to control the ground water situation and we want to do the remediation and then not do pump-and-treat to follow.

If you try to look at a RESRAD type modeling, which is what we're doing, you can't match those two. You've already got a ground water contamination. In our case, it's a ground water contamination in fractured bedrock and our remediation is not going to touch that. It's beyond our reach.

So our approach right now is trying to decouple the two from the standpoint of analysis and look at the ground water modeling, like MODFLOW, I think it is, I forget what the model they used, to deal with that segment of ground water contamination and project that into the future, and then to -- because RESRAD looks at a contamination of ground water for ground, and then the transport adding to it, look at that separately.

Then you have to take, in my view right now, in trying to deal with this, is break your criteria up into two elements, a fraction of it for the MODFLOW in what exists now and a fraction of it for what we'll add later.

That's the approach we've been trying to do, because we don’t know how to take the models and link them directly.

I’d like a comment -- well, I’m going to get a comment sooner about that approach, but that’s what we’ve been fighting with.

MR. EID: I have no comments into. It needs to be looked into in more detail, to be fair. It is unfair to answer you on this part directly one way or the other. I think we take a look at your approach and most likely it will come to the PA group to take a look at this approach, if it is innovative and if it is not, it is slightly more complex than the normal case.

MR. NARDI: With respect to question one, I just don’t know how you use it to project into the future; past data to project into the future. That’s a very difficult thing to do, particularly when past data has been modified by practice, such as pump-and-treat.

MR. THAGGARD: I think, clearly, if you’ve only got a ground water source and you remove the surface contamination and you’re only dealing with ground water source, the answer to this question is you should use the data, because that’s better than any modeling you can do.

Certainly, if you can monitor how fast that contamination -- that plume is moving, how fast it’s migrating, you can get a much better estimate on what the concentration is going to be in the future based on the monitoring information than you can ever do with modeling.

Unfortunately, most of the problems -- we have this dual problem where we’ve got not only existing contamination, but we still have a source or potential source where we can get additional contamination in the future.

So it becomes a problem of coupling those two together and integrating the analysis.

MR. NARDI: But my point exactly was that we have 15 years worth of data of using pump-and-treat to shrink it. That has nothing to do with movement away.

MR. CADY: Gene.

MR. WHELAN: I had one additional comment, and that is that at many of the sites we deal with, the difficulty I'm hearing here is that we have two situations. One, we have current contamination that exists due to past practices and then when we want to do D&D, we have the potential of the contamination that may occur because of the D&D process.

What we have done in the past with that situation is we have used the past contamination to help us identify the hydrogeologic, hydrodynamic parameters that would then be used in the D&D assessments. For example, if I had nitrates or something that didn't absorb well to soils, it would provide me with an idea of what the flow velocities were, the direction of flow.

Other contaminants could give me ideas of suggested values of Kd, et cetera. And that information could then be used for the second stage analysis; that is, the license termination analysis.

So although it may not be the same contamination, the same potential contamination or exactly the same situation, it could provide information that makes that analysis much more accurate and more palatable to the regulators.

MR. CADY: Thanks. All right. How about the fourth question, when is it necessary to go beyond one-dimensional ground water models, and do two and three-dimensional models? Any takers? Nobody from licensing is doing anything other than smiling.

MR. EID: I think for the cases I'm familiar with, it is very difficult to define many cases to say, yes, you need to use more than a 1-D model. In decommissioning, it is very difficult to go to complex modeling because of the need of the data and the extra expenses and because that already the models that we are using, whether 0-D or 1-D, they are already conservative, and we are trying to be a little bit more conservative, to have confidence, while we are protecting the health and safety of the public.

If somebody wants to go and use 2-D and 3-D in order to reduce such kind of level of conservatism already in the 0-D and 1-D models that are available, I would say I would leave it up to the licensees to use it. But to say that you must use 2-D and 3-D model and to give a specific case, I think, it's very difficult for me as a regulator to define this kind of case.

MR. CADY: Yes, Henry.

MR. MORTON: Henry Morton. Isn't there also a kind of corollary question here? When is it advantageous to do 2-D or 3-D modeling? And part of those -- the factors there are -- at least immediately, I think it's when is dispersion particularly making a difference here.

Then, secondly, do we have the data to feed or support the more complex model or is it worth the expenditures of the money to get the data to support a more complex model, or, on the other hand, is it necessary to get the data, if we don't have it, that support the more complex model.

MR. CADY: I think this question has embedded in it some assumptions and some of those are that some of these existing are not multi-dimensional. The ground water flow model in MEPAS, it's my understanding that it's at least two-dimensional, right?

MR. WHELAN: Three-dimensional dispersive, one-dimensional.

MR. CADY: Right, 1-D advection and 3-D dispersion. Okay.

Moving on to number five, when it is appropriate to model a site as a simple unified layer as opposed to several distinct soil horizons and/or rock units above the water table. So we're talking here primarily about the vadose zone or the unsaturated zone. Anybody?

MR. NARDI: Joe Nardi again. In our specific situation, one of the areas that we have is a buried basin that was buried in the ’60s and we are going to go back and dig that up. That’s going to essentially require us to dig down to bedrock, and bedrock, in essence, is the ground water interface.

When we put it all back together, we’re going to basically backfill with one media and, to me, that would be an appropriate time to do exactly that, where you just have one horizon, if you want to call it that, of uniform properties, because for practical purposes, that’s what will exist.

MR. CADY: Thank you.

MR. THAGGARD: I think another issue is how complex do you want to get with trying to analyze the migration through the unsaturated zone. It may be somewhat dependent upon what it’s doing in terms of buying you anything, because most times, the way we are modeling the migration through the unsaturated zone, it’s almost like a delay function.

So trying to model the unsaturated zone to a very fine degree may not be all that important when all you’re doing is buying yourself something in terms of additional decay. And if you’ve got a long-lived radionuclide, you’re probably not even going to get much in the way of that.

So I think there needs to be some consideration in terms of how important that unsaturated zone is to the analysis.

One other point I’d like to make, though, is one of the things I think PNNL has found out in looking at the D&D code was that the D&D code uses that one box for the unsaturated zone and by using that one box for the unsaturated zone, we’re basically assuming infinite dispersion, and that could be very non-conservative.

So there is some recommendation that you need to break that unsaturated zone up into multiple zones, and I think that’s put out in the report by PNNL and we're certainly going to encourage people to do that, because that's a very non-conservative situation.

I don't know if Phil wants to say anymore about that.

MR. LEE: I would just like to add another comment on that. From the ground water modeling point of view and from the -- particularly, from the numerical point of view, because the ground water modeling we saw in these two says is trying to solve the differential equations.

So in that point of view, we have to use a fine grid. Instead of one layer, we have to have just a few layers in order to treat the numerical diffusion, try to avoid that numerical diffusion. That's from the numerical point of view.

So I still insist I'd like to have more than one layer, yes. If you only treat the analytical solutions, yes, we can use only one layer, that's good enough. But if you want to solve for the differential equation, we have to have more than one layer in order to avoid the numerical diffusion.

MR. THAGGARD: That's not quite the same as -- I mean, the number -- you mean in terms of the number of grids, breaking the grid up in terms of -- yes, I agree. In most cases, you can't get by with a grid of -- having a single grid for the unsaturated zone. If you're doing a numerical analysis, but I think in most cases, what we're talking about here is not numerical analysis, but yet if you're doing a numerical analysis, you do have to have -- find enough resolution so that you don't get numerical dispersion, which is kind of what I had touched on with the problem with the D&D code, where we're assuming that single zone for the unsaturated.

If you assume a single zone for the unsaturated zone without breaking that up, you, in effect, are going to get a lot of numerical dispersion there, because you're getting infinite dispersion. So we're recommending that people break that up.

MR. EISENBERG: Except there are some numerical algorithms that avoid the problem or the numerical dispersion. Particle tracking algorithms would avoid it. So you don't have the same limitation.

MR. CADY: All right. How about modeling water table aquifers that have multiple sources? Gene, how would you do that?

MR. WHELAN: Well, we've done it. We've done it kind of for 1,200 waste sites at Hanford, and what we've done is we've used a super-position of the contaminants from multiple waste sites and the flow paths intersected in the saturated zone, some location, down gradients, and those were superimposed to come up with the combined concentrations for like constituents, like strontium-90, for example.

So a super-position has been used in the saturated zone. We've also used it in the vadose zone, where we have varied the flow field; that is, an approximation to transient flow, even though these models assume steady-state hydrodynamics.

So super-position actually works fairly well. It's approximation, but it's not a bad approximation.

MR. CADY: Thanks. Yes, sir.

MR. KUHLTHAU: Rick Kuhlthau. I'd just like to make a quick comment on super-position. If you have plumes coming from two different sources and the likelihood that they actual commingle at some point in the distance, is that really the representation of reality? Would they really commingle or come close to each other?

In other words, this mixing of a plume downstream with another plume, they're from different sources, I really question if that's physically what would happen, because they all have their own separate flow lines.

These flow lines aren't going to come together and merge. There may be a concentration of flow lines and maybe it's a matter of scale, but in the end, I doubt, except as dispersion would account for it, that you could get mixing like that.

MR. WHELAN: The way which the flow lines were defined were by these three-dimensional numerical models and the concentrations in these more simple models, the way we handled them were we identified around nodal points certain volumes, if you will, and the -- it's really the contamination that is associated with that controlled volume.

Again, the technique or approach that you use depends upon the questions that you are asking and as I noted, do the numbers match exactly? No, they do not. But in these particular instances, because we then went back and compared them, the concentrations, although they were not exact, they were in the ballpark and in the ballpark of risk assessment, we're talking well within an order of magnitude, factor of two.

So for our analyses, it was good enough for the questions that we were asking. For other analyses, it may not be good enough for the questions that we're asking.

MR. CADY: Thanks. Norman? Never mind. Any additional complicating factor would be at the well. If you're actually simulating the well, then you'll have convergence and it would be possible to induce portions of multiple plumes.

MR. KUHLTHAU: I guess it's like I ought to offer a warning, particularly for the regulated community, that that is not -- it is very -- it can be a conservative assumption, it can work against people when they're trying to add these plumes together. In some cases, it may not represent their situation and it may definitely not be to their benefit.

MR. CADY: How about the final question, if the ground water model considers dilution of the radionuclide sources, what site-specific and pathway scenario features -- for example, ground water wells -- and processes -- for example, dispersion -- warrant consideration in making the dilution calculation? Should the ground water well be treated as a pumping well?

I think we've heard points over the past few days for considering the ground water well to be a pumping well and approximations to that.

Does anyone have anything further to add?

MR. NICHOLSON: One point that was made yesterday, and I don't know if anyone wants to discuss it, but with regard to the scenario, where is the well screen, not only is it a pumping well, is that well being used for a single family or a community and, also, where is the well screen located within the aquifer and its relationship to the anticipated or projected contaminant plume.

MR. RACINO: Roy Racino, NES. In regard to pathways and scenarios, I want to back up a little bit to a question that was before one of these. Specifically, in justification for elimination of pathways.

I think we've covered pretty well some of the justifications for eliminating drinking water pathways or things like that for shorter-lived isotopes, but when you get into the long-lived radionuclides, like a few people here are dealing with uranium and thorium sites, what would be the justification for or would there be a justification for eliminating pathways?

I know Dr. Neuman touched on the fact that in a relatively short amount of time, there can be drastic change. So if you use past, present and future population data, land use data, water use data, is that really going to be a justification when you're going out the full thousand years, as far as the criteria?

I was just wondering if you had any feeling on that, if somebody submitted something, if there is any feeling.

MR. THAGGARD: I think what I said yesterday is that that's what we're considering right now. We haven't reached a position on that yet, but these are the kind of arguments that we're in right now and I think the gentleman from NFS mentioned about -- talked about his problem yesterday and they're raising some of the same issues at their site.

So this is a broad-reaching generic issue that we're going to have to provide some guidance on, and we haven't gotten to that yet. We haven't reached that point yet.

MR. RACINO: Thank you.

MR. EID: I believe I gave a vivid example yesterday in my presentation, that the classification of the aquifer is quite important and if the aquifer is classified as not used for irrigation or for drinking, this could be sufficient justification for elimination of the ground water pathways, as a clear example.

Again, for using the soil, if the soil currently and in the future is going to be soil not useable for agricultural purposes, also, you could eliminate that pathway. If you are to bring water for irrigation from somewhere else, typically you do not bring contaminated water from somewhere else, you will bring clean water. In this case, you could eliminate the ground water pathways. Meanwhile, you could deal with the long-term planning if the soil could be useable for agricultural purposes, then you maintain the agricultural pathways, considering irrigation with clean water.

Another example I could give for elimination of pathways, if you are living in a highly populated urban area, where you know that nobody is going to be a residential farmer in that specific area, it is a big city, you are in the middle of the city. At worst condition, you may have a gardening scenario, if you have very large land. If you have a small site, this means this could be even you could have somebody just occupying a building without doing gardening.

So using this kind of analysis and approach, you need, of course, to give some supporting information to justify eliminating those pathways.

So those are the examples now. We'll be, of course, developing this further, giving it more thought, and then putting it in the SRP.

MR. THAGGARD: I'd like to clarify something that Boby made. I think as a position right now, clearly, if you can argue that there are physical limitations to the use of that pathway, then I think those are the kind of arguments that we would probably look at very -- you know, there wouldn't be much in terms of arguing about physical limitations.

When you get into these other forms of justification, for example, current land uses, I think that's where we are still trying to figure out the specific guidance that we want to give people for the type of arguments, because there's a lot of issues that need to be resolved in terms of how long of a time period you want to use and what area you want to consider.

So we haven't resolved any of those issues yet, but clearly if there are physical limitations -- for example, you can't get the yield or the ground water is salty, salinity arguments, I think those are reasonable arguments that can be made even today.

But when you get into these more cultural type of justification, we really haven't resolved those yet.

MR. EID: Some of those, they have legal implications. That's why we are hesitant to say for sure those are the ones. Of course, we have to go through the legal process to be sure what we are saying is legally acceptable.

MR. KIRK: Scott Kirk, NFS. I would just like to raise the point that in the current guidance, DG-4006, it talks about use of specific site information. It states that you can use or consider as reasonable current land uses for the period of the dose assessment, which is a thousand years.

I can understand how that may not be all inclusive for all scenarios, but at least for determining land use scenarios, whether it be a resident farmer, suburban resident, that that particular guidance that exists now should apply to the licensees at present.

MR. EID: I think this is a consideration factor, but it will depend on the site conditions. This is just broadly stated, but you need to analyze what other factors also.

MR. KIRK: Thank you.

MR. CADY: For session number three, I believe we touched on the first two questions. Was it necessary to modify the ground water model to make it compatible for linkage to the dose assessment module? Please explain.

MR. EID: I will give it a shot on this. I believe, yes, it is necessary to link it because it is very important factor, which is the decay factor. If you try to calculate the transport for the ground water model without linking to the dose assessment model, maybe you will be ignoring the decay factor in the process of the transport.

Another one, linking the time when you try to pump the water for the other pathways, for the resident farmer to pump the water at the same time. So the timing is very, very important in this case. This is an example of where it is important to link the ground water pathway with the dose modeling assessment.

However, there are certain models that you could derive the concentration, input it in the code, and they can be linked, and just I caution that we need to be sure that they are compatible with each other.

You do not sometimes -- these models, you may do the process twice, like you have the pathways could be overlapping on each other.

You need to be sure you are not, for example, having two pathways at the same time, or, vice versa, eliminate certain pathways.

For example, the ground water model in D&D assumes the concentration in the pond is the same concentration in the aquifer. Now, if you do not properly link that scenario with the ground water model and you eliminate the fish pathway, whereas under typical conditions or a complete residential scenario, you would need to consider the fish pathway.

This is for initiation of the dose modeling process. This means you could have eliminated a significant pathway, and that significant pathway could be applicable to some radionuclides or significant to some, like carbon-14, whereas for some other radionuclides, it is insignificant.

So in linking the ground water model to the dose assessment is quite significant because of the decay, because of the time factor, because of the compatibility of the pathways together with the ground water pathways.

MR. LEE: I'd like to add a comment on that. I agree, it's very important. We have to link the ground water model with dose assessment, because the reason I say that, because the ground water model really can give a lot of the different distribution of the concentration and a different depth or a different time zone and everything, that's right.

That is quite different from that currently taken for the ground water model. So from that sense, I think that it's very useful to link a ground water model with dose assessment.

That is why I try to continue to pursue in that direction.

MR. NICHOLSON: Could you say something about what your thoughts are?

MR. LEE: Probably, I'm thinking that -- yesterday, I with

Gene. Probably I ought to continue to work with Gene and we link with the model with the dose assessment. That's right. I think that is a way we have to pursue.

MR. NICHOLSON: Thank you.

MR. EID: Also, to add more linking with the scenario itself is very important. As we explained, the receptor location. So you need to link the scenario in the dose assessment model with the ground water model, the ground water pumping, location of the well, and so on.

MR. CADY: Yes, Henry.

MR. MORTON: Henry Morton. Gene explained yesterday his dealing with FRAMES, in a global manner, and what I was trying to describe earlier today, an interest in a more immediate matter of this kind of linkage of the output from, in this case, ground water modeling to the input for the programs like D&D and RESRAD.

It seems to me that at this point in the near term and as a practical matter, we need to think of both what is needed perhaps to modify the ground water model or the coding of a program that produces that to get the right information out, and, at the same time, think of what kind of input -- that is, what modification might be best and most nearly universally compatible in the dose assessment programs, like D&D and RESRAD, more to let these two mesh with the least pain in the near term.

MR. CADY: Thank you. Norman?

MR. EISENBERG: I'd like to ask Henry a question. It seems to me there are some codes out there, that if you input concentrations, they will calculate doses, and we haven't talked very much about how to just get out of the whole mode of D&D and RESRAD and move over to that suite of codes.

Could you say a few words about those?

MR. MORTON: In actuality, I've continued to mention these two, for the reason of experience and the sense that, both from the regulators' viewpoint and the licensees' viewpoint, this is where the experience is and the sense then on my part that this might be the most acceptable way for us to deal with this in the near term.

I have a sense from previous workshops that justification of using some other program -- that is, mathematical -- coded mathematical models for all pathways and models that then go on to take the intake, calculate organ doses, do the organ dose weighting, produce the TEDE, that is the dose equivalent, these two codes do that in a way that seems to be generally acceptable and for which I have a sense that we won't have to go through a great deal of discussion to justify to one another that that's an acceptable way to do this part of the arithmetic.

So that's why I keep mentioning these two programs as what I think are now the most nearly acceptable ones. It's a matter of how much defense, how much verification, benchmarking, inter-comparisons with other programs might be needed.

MR. EISENBERG: But the catch is that D&D, for example, was intended to be a screening code and was not necessarily designed to accept inputs from complex ground water and transport models so that it could then calculate dose from that and some other codes.

I think -- I'm not an expert on all this, but I think we're talking about things like the GINNI code and possibly other codes like that. Those kinds of codes might be more easily adaptable to some of the complex ground water flow and transport codes. And I'm not sure that the staff a priori is going to say you shouldn't do that.

You are right, there will be some burden for justification of the use of those codes, but I'm not sure that we should just automatically rule it out.

MR. MORTON: In concept, I would agree that that's true. As a practical matter, there are some questions then that need to be answered as I consider other coded mathematical models for this program. The question then is who would do the modification in order to enable this linkage to be done, who would do the modification? Well, that may depend on who is supporting it and there is a key question.

If the owner of the code will not contribute the source code for someone else to do the modification and the verification, then we can't do that physically.

To my knowledge, first, I have asked historically for the source code from GINNI. No. To my knowledge, from what I've heard in workshops here in the last year or two, source code would not be available to me for either RESRAD or D&D. If that is the case, which it seems to me it is, then I can't do it. I would have to depend on the owner of the code to do it, and that's an uncertainty.

We basically, I think, from an industry viewpoint, have to stand here and basically ask for what I've asked for today; that is, if the owner has configuration control, then we have to depend on the owner to provide the modifications that will enable us mechanically to get these things done, be able to have this mechanism that most conveniently does the arithmetic and combining the different pathways into one eventual one, as a practical matter, that seems to be the case.

So the two likely candidates, I think, remain RESRAD and D&D for the reason that there are two agencies who are continuing to support the maintenance and development of those codes.

As a practical matter, to take other codes and adapt them somehow to basically produce an output that will become the input to those in whatever way, we can do that only if the owner of that code accommodates us.

MR. EID: I would like to reiterate, again, as a general policy, the licensee could submit any code that he wished for site-specific analysis. Of course, there will be more burden on both the reviewer and the licensee to provide more information on the code and justification of the code if the code is not well known.

Like, if it is in-house, developed by a single person and he thinks this code fits the process, this means it will require more information to look at the code and the QA/QC of the code and to look at the equations by both, by the, of course, licensee, if they submit such kind of code, and also by the regulator to review the process for deriving the dose.

So in other words, if you have more common codes available and they are used more commonly by the licensee community and by the technical community, they are using dose assessment, it would be much easier for you to establish more confidence.

Of course, also, we need to look at the cases. I disagree with you that only because they are available, just only D&D and RESRAD, I think you need to look at a specific case.

For example, if you come with RESRAD and say I use RESRAD for on-site analysis, I may give it some argument and say is it really indeed the best code that you could use for on-site analysis -- I mean, for off-site analysis.

So in this case, we have a specific case now, a decommissioning case, where RESRAD was used for on-site analysis and MEPAS was used off-site. So I think this is an example where depending on what you are analyzing, where is the receptor, is it on-site or it is off-site.

For on-site, for example, if your site is about a diameter less than 100 meters, it would be very difficult to justify a gallium plume, for example, for the inhalation pathway. So this is a fact that you need to take into consideration.

So a gallium plume, for on-site analysis, if the site is very, very small, I'm giving the example of 100 meter, it could be --

somebody could argue it's 50 meters, this is the example where we could use on-site and the suitable code for that case or condition and off-site, and in this case, I would say it's not just only two codes. There are other codes available on the street and they could be good and suitable for that condition.

MR. MORTON: I would agree with that. There will be cases in which we'll look at the case and we'll realize that there are other codes that may be more appropriate. I think with respect to ground water, that's the whole workshop here.

Then when we get to that point, then come the practical considerations of one of the questions I raised, which is, in effect, the nature of justification to be able to use an alternate code and the value of doing that versus the cost.

MR. CADY: And I'd like to clear up one misperception. The FORTRAN code for D&D is published in the most recent 5512 volume. So that is available to you.

MR. MORTON: Basically, there is a difference between having the FORTRAN code and being able to read it and do some things with it, and then having a program that will execute it on a computer. Short item, how much effort to type in seven or 8,000 lines of FORTRAN code or however many thousand lines it may be.

These things, theoretically or conceptually, may well be true. As a practical matter of execution, it may be simply too much or inconvenient to do.

MR. THAGGART: While Walt is standing up, let me just say that I think what Norm was trying to point out is that there is a practical limitation to how much you can modify codes that are designed primarily for screening purposes.

When you start getting into real complex analysis, where you're talking about having to do detailed ground water modeling, you're really starting to fall outside of the limitations for some of these screening codes. So you're going to probably have a burden on your hands anyway at that point in terms of justifying what you've done.

So there's some practical limitation as to whether or not you want to modify these screening codes or these simpler codes to handle every one of these little isolated problems or put more of the burden on that particular individual to deal with that particular problem and keep the -- you know, so there are practical limitations on however you do it.

Sorry, Walt.

MR. BEYELER: No, that's fine. I just wanted a response to Henry's question about the source code. If the source code is listed as part of volume two, then it should be available on our FTP site and if it isn't, I will look into that and get back to you on making that available to you electronically.

MR. CADY: Part of the problem is that there are elements within D&D, commercially available libraries, where we clearly can't give you the source for this charting package and so on and so forth. So there are some problems with distributing elements to this.

MR. MORTON: I think, to be clear on it, I'm really not standing here asking you to do it, to give us the code to change it.

Clearly, what I'm really asking for is provide some plug-ins where the best mesh of input of data can be done so that we can enter data without having to go modify the code ourselves. That would make it most nearly compatible for a broad range of users.

So that then you have a definition of what the inputs are. And there is this now, there is that ability, in a defined file, where input of drinking water and it's that kind of thing that I'm interested in in order to make, in this particular case, the best mesh between the output of some of the ground water models that we've talked about today and the input to the code that will handle the rest of the arithmetic.

MR. CADY: Thank you.

MR. MORTON: I'm not making any effort here to wrestle away the source code and let them keep the source code and keep configuration control, but --

MR. EISENBERG: But what I'd like to ask is, is this a general view of the licensee community that they would like to see D&D modified in this way because NRC gets its money from the licensees. So if we're going to do it, you guys are going to pay for it.

MR. BURKLIN: Rich Burklin, Siemens. I think that most of us in either the reactor community or a fuel fabrication facility or business are going to use RESRAD and, therefore, all these modifications that are proposed to D&D really don't do us any good.

So just speaking for myself at least, I don't see putting a lot of money into making a lot of changes into the code that we probably aren't going to use.

MR. KIRK: Scott Kirk, NFS. I think what Dr. Whelan said really hit home; that we use the codes that we're most familiar with. We're most familiar with D&D and also RESRAD. Some of us do have a need to decouple the ground water pathway and to do more detailed analysis, but currently there is no link, without us doing a lot of innovations, so that we can estimate how much daughter ingrowth would occur at various periods of time within the water table, and also to use that information to calculate dose.

And if that linkage was provided, it would be very beneficial to us really right now.

MR. CADY: Thank you.

MR. BURKLIN: Rich Burklin, Siemens. I'd like to make another comment in here. As I understand it, what we need to do is we're going to choose a code and then we're going to justify that code to you. We're not going to be in the business of saying we chose that code, but we didn't choose these other five codes in here, even though someone may argue that they're better. Is that correct?

MR. EID: That's fine. That's acceptable, yes.

MR. BURKLIN: And one other thing that I noticed today in here and which has some concerns for me is that in Phil's talk earlier today, he had two points of data and I think -- I'm sure that we're going to get more than two points of data for lots of these things.

But then he drew a distribution using Bayesian techniques, which I'm unfamiliar with, in here, which was skewed to one side of those two points here.

In one case, it may be conservative; at another point, it may be not conservative. But that distribution is different than you would get if we just had those two points and used classical statistics.

Again, I am concerned about having to go in and explain, well, why didn't use Bayesian here. Do you understand what I'm saying in here? You can get different distributions, and I don't want to really explain to -- going through the explanation why I didn't use a different set of statistics.

MR. THAGGARD: That came up during my discussion point and that's why I said that you can use any method you want. I think Phil just basically presented his idea, his tool for how he thinks it could be done, and that's why I was trying to solicit to see if there were some other ideas out there for how people can do it.

But certainly if there are other ways to do it, you can certainly use whatever method you want.

MR. CADY: The final question in this session would be how does one test the modifications and linkages to determine whether errors and/or uncertainties are being introduced in the dose calculations.

I think essentially we touched on that when we were talking exclusively about the ground water models. Is there anything that anyone has to add? Henry?

MR. MORTON: Yes. That's where, at least in my broader concept, keeping this interface clean, defined, will help to do that. That is, if we define this interface somewhat in the way that, in one case, D&D has done it, let the owners of that code be responsible for that side of the interface and let the owners of the other code be responsible for the other side.

Then it's a matter of matching input and output. That interface then becomes cleaner and you don't get the crossover.

MR. CADY: Thank you.

MR. NICHOLSON: Are there any more comments or suggestions on that last question?

[No response.]

MR. NICHOLSON: Okay. Well, we've reached the end of the program, and now it's time for closing remarks. I just want to say, for the record, that there will be, as I said earlier, an official transcript that we put in the PDR here in Washington. We are hoping to put together a proceedings of this workshop six months later.

We have passed out the viewgraphs to all of the presentations except for one. All of them, including the one from Argonne, will be in the public document room with the official transcripts.

The last thing is I want to personally thank all the speakers and the Federal agencies that support them. We had presentations from the national labs. A lot of that work in EPA was not supported by the NRC and we want to thank the Department of Energy and the Environmental Protection Agency. We also want to acknowledge all the speakers that came from all over the United States and the effort you people put in preparing those presentations. We really appreciate it.

I'd like to now see if there is anyone who would like to comment before the final remarks from industry. Are there any comments? Yes, sir.

MR. ROBERTS: Rick Roberts. Through these last two days of talks, I thought there would be one issue talked about that was never brought up.

In your decommissioning rule for building surfaces, you decommission your building surfaces to a building occupancy scenario and buildings obviously will not be there for more than, say, 50 years, they have a useful lifetime. But we have to assess does over a thousand-year period.

And one thing that has come out in the last few sessions is that we're going to have to assess the dose to building rubble over a thousand-year period, we can't just stop at the 50 years. We have to look out into the future, as well. And I don't know if it's -- where this will be discussed or where in your plans this will be put, but somewhere it needs to be discussed and really put down how you would assess radionuclides that are left on building surfaces in the timeframe from 50 to 1,000 years.

And I think, in bringing this up now, my feeling is that really the ground water pathway may be a very applicable and probably a predominant pathway in looking at radiation doses to building rubble in the future.

I was wondering if you could comment on that dose assessment and where those issues may be discussed.

MR. EID: I believe the purpose of this workshop is ground water modeling. In the regulation currently, we have a Federal Register notice for the surface contamination levels for the most common radionuclides, for beta and gamma; also, D&D screening test the release values or the limits that you could release a building.

In the EIS that supports the rule, there were analyses to show that if you comply with the surface contamination criteria for the building, if you comply with it, this means you are home free. You do not need to do any further analysis.

So the ground water pathway, in this case, if you comply with the surface contamination criteria, it does not apply. There is no ground water pathway.

However, some licensees, they may propose they cannot meet the criteria and they would like to rubble the concrete. This means the scenario in this case is not any more a building kind of scenario. It will be another kind of scenario, which the ground water pathway could be an important pathway.

For that specific condition, where the licensee comes and says I do not meet the criteria for the building scenario, this means we may need to add this to the ground water pathway.

So for surface contamination, the licensee demonstrates compliance with the surface contamination levels on the building scenario, you do not need to issue a ground water pathway.

MR. ROBERTS: I guess it sounds like there's -- at some times, you may need to assess it, and other times you may not. Is there some way you could give guidance in your standard review plan on when you would need to assess building rubble in the future, after a building is put down, and when you would not have to assess it?

MR. EID: Again, if you meet the criteria, you do not need to assess the ground water pathway. If you do not meet the criteria, this means the scenario is not any more a building scenario, it would be another kind of scenario, and we will provide more guidance on that.

MR. ROBERTS: Okay. And just for the record, what you just said, I think, is contradictory to what was said in the last workshop.

So I think -- I don't know. Maybe --

MR. EID: I do not recollect if we said something different. We said always building scenario does not have a ground water pathway and if you comply with the surface release criteria, this means you are in compliance with the dose criteria.

But if you select to have -- if you have higher concentrations and then you say I'm going to rubble the building and then the scenario in this case will be different.

MR. EISENBERG: Norm Eisenberg. I just wanted to say something left over from yesterday regarding some of the remarks from Professor Neuman, regarding the need for 3-D modeling and site characterization.

From a ground water hydrology point of view, I'm sure that's something that is important, but the NRC staff is interested in protecting public health and safety and having sufficient information to make those kinds of regulatory decisions.

And I don't think the staff has any interest in requiring the licensees to engage in any more site characterization or complex modeling than is needed to prove the regulatory point.

Certainly, our screening code is a very simple code and can be used for screening, unless site conditions rule out its use.

So we are quite willing to accept lesser forms of modeling and site characterization. All we need is what you need to prove the point.

MR. MEYER: Phil Meyer. Since Dr. Neuman is not here to speak to that issue, I thought, since I have spent most of the week with him, that I would just respond to that. And he can always take a look at the record later and see if I represented him correctly.

If you recall his framework, working from a contextual framework for the analysis of the site down through the actual quantitative numerical analysis of the problem, he pointed out that you get down to a point where you're developing -- you've developed a conceptual model of the site and you're preparing to translate that into a mathematical and implement the mathematical model.

His assertion was that there was no reason not to represent the site or conceive of the site in less than three dimensions, up to the point where you are formulating your mathematical model.

From that point on, if you feel that it's justified to go to 2-D or a 1-D implementation of a model, then do so, but start from a three-dimensional framework, since we know that the real world is three dimensional, and then formulate it correctly. Formulate your 2-D or your 1-D implementation in a manner that is consistent with that sort of averaging.

MR. NICHOLSON: Any other comments?

MR. MEYER: Can I just finish up one? I just wanted to make a point. He was not advocating that three-dimensional numerical modeling is required at every site.

MR. EISENBERG: I think sometimes it was easy to conclude that just from listening to him and I think we're not really that far apart in what we're saying.

It's just a slightly different approach. You would go to a certain point and make an assessment as to whether you needed 3-D modeling. I think you need to look at the site and decide perhaps from a minimal amount of site data whether you need to even get into that game.

It's just a question of, I think, the sequencing.

MR. NICHOLSON: Any other comments?

[No response.]

MR. NICHOLSON: Okay. Before I turn it over to our last closing remarks, I want to make a point of thanking Jack Parrott, Boby

Eid, Mark Thaggart, Ralph Cady, and all the other people that helped out from the NRC staff. I think it was a real team effort on the part of both Research and Licensing and I really appreciate it.

With that, I would like to turn it over to John Greeves, the Director of the Division of Waste Management in the Office of Nuclear Materials Safety and Safeguards. John?

MR. GREEVES: Thank you. I know who's got the real stamina now. Take the names of all these people.

MR. NICHOLSON: We have their pictures, as well as their names.

MR. GREEVES: Wonderful. I want to -- I made some opening remarks, with Tom King, and I'm sure Tom would like to be here. I don't see him, but for both Tom and myself -- did Tom come back? Tom and I agreed that whoever was here would convey comments from both of us.

So I want to thank all of the workshop participants for helping to make this a successful workshop and exchanging your views. I was able to sit through almost the better part of a day. So there were some good exchanges, and we all profit from that approach.

The Licensing Office, that I represent, wants to thank the staff of the Office of Research for helping organize and run this workshop. Tom and I really appreciate the effort that you all have gone through. I'm not going to go through all the names, because I'm sure I'll forget somebody, and I don't want to do that. I think you mentioned the main players yourself, Ralph Cady and others. So I really thank you for doing that. It had all the markings of a successful exchange.

We especially appreciate the input and the data that you, the licensees, the stakeholders, provide and input to our deliberations, to assist the staff in drafting the standard review plan. Those remarks I made during the first day in response to a question, well, how do we know what we can use; well, we need to write that in the standard review plan and lots of the material that you're providing in these workshops is the sort of thing that we can deliberate on, capture it, write it into the standard review plan, saying this is what we're going to be doing at the staff level.

So these inputs have been very valuable in past meetings and those received during this meeting. They are quite valuable to all of us.

One thing I want to emphasize, I was thinking about it, I spent about a half a day yesterday and went back to the office, based on some of the things I was listening to.

I don't agree with everything everybody said in the last two days. I'm sure you don't either. But what's going on with the staff? And this is our responsibility. We have to explain, present what our vision is in decommissioning, and the two opening speakers, Boby and Mark, went through the process, talked about the NUREG-1549, that's a good road map of how you walk through decommissioning, from simple to complex.

It's what I call a graded approach. If you can get out early with a simple approach, we want that to happen. We don't want to spend scarce regulatory resources on cases that just don't warrant additional work.

So whether you are able to work on the simple approaches or you need to do a bit more complicated approach, some of these 3-D models, it really is case-dependent. We use D&D, we use RESRAD. In fact, we're investing in RESRAD. There are some enhancements we'd like to see. I hope somebody mentioned that in the last two days. And you're going to find that those are written into our standard review plan.

And we don't want any particular licensee going to any length greater than necessary to demonstrate that you meet the rule.

There was a lot of discussion the last couple of days about complicated approaches. The labs have tremendous resources to develop these codes. I think that's useful. The context is good. The experience is good. But there is not an expectation that the majority of our licensees would have to approach that level of analysis. So we're going to make that clear in the standard review plan.

And I think that sort of summarizes what I thought were the important comments. With that, thank you all for coming.

MR. NICHOLSON: Thank you.

[Whereupon, at 4:15 p.m., the workshop was concluded.]