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NUCLEAR REGULATORY COMMISSION

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ADVISORY COMMITTEE ON NUCLEAR WASTE

167TH MEETING

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WEDNESDAY, JANUARY 11, 2006

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The meeting came to order at 9:30 a.m. in room T2B3 of Two White Flint North, Rockville, MD. Michael T. Ryan, Chairman, presiding.

PRESENT:

MICHAEL T. RYAN	CHAIRMAN
ALLEN G. CROFF	VICE CHAIRMAN
JAMES H. CLARKE	MEMBER
WILLIAM J. HINZE	MEMBER
RUTH F. WEINER	MEMBER

ALSO PRESENT:

MICHAEL SCOTT	DESIGNATED FEDERAL OFFICIAL
ASHOK C. THADANI	DEPUTY EXECUTIVE DIRECTOR
LATIF HAMDAN	STAFF

I-N-D-E-X

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

9:32 a.m.

CHAIRMAN RYAN: All right, if I could have your attention. Good morning, the meeting will come to order. This is the second day of the 167th meeting of the Advisory Committee on Nuclear Waste. My name is Michael Ryan, chairman of the committee. The other members of the committee present are Vice Chairman Allen Croff, Ruth Weiner, James Clarke and William Hinze.

During today's meeting the committee will (1) be briefed by the staff on the capabilities of Version 4.1 of the Spatial Analysis and Decision Assistance Bayesian Subsurface Analysis Code. We will hear presentations by and hold discussions with representatives from the Federal Railroad Administration on the use of dedicated trains for transportation of spent nuclear fuel and other high-level radioactive waste to the proposed Yucca Mountain Repository. Three, we will brief the Commission on recent and planned activities. This briefing will take place at a different location in the Commission Briefing Room in 1 White Flint North. That will commence at 2 o'clock, and the schedule is from 2:00 to 4:00, for those that are interested. We will discuss proposed committee letters and reports.

Mike Scott is the designated federal official for today's session. This meeting is being conducted in accordance with the provisions of the Federal Advisory Committee Act. We have received no written comments or requests for time to make oral statements from members of the public regarding today's sessions. Should anyone wish to address the committee please make your wishes known to one of the committee staff. It is requested that speakers use one of the microphones, identify themselves and speak with sufficient clarity and volume so they can be readily heard. It is also requested that if you have cell phones or pagers that you kindly turn them off at this time. Thank you very much.

Without further delay I will turn over. The two next presentations will be led by Dr. Weiner. Dr. Weiner?

MEMBER WEINER: Thank you. I'd like to welcome George Powers from the Office of Research to talk about the Spatial Analysis and Decision Assistance program that is being carried out by NRC along with a number of other federal agencies.

MR. POWERS: Okay, thank you very much. The last time I was here this program was just getting underway.

CHAIRMAN RYAN: Do you have a lapel mic on?

MR. POWERS: Oh, I'm sorry. There, is that? Okay.

CHAIRMAN RYAN: That's great.

MR. POWERS: I can hear myself more than once. And it was started for several reasons, which we'll get to in a few minutes. But anyway, the primary purpose for getting into the involvement of this particular development was to try to pull together a more realistic and dependable estimate of exposure and the parameters leading to determining what that exposure is. And we elected to -- one of the problems we've run into in the past are the number of additional samples. There is an incredible amount of effort out in the field wasted on bad sampling, taken in the wrong place. So what we begin to do is begin to optimize the sampling and the analysis that's going to be involved.

Now, is it new? No. Argonne National Laboratory is kind of where we got our start on this. There's a guy up there by the name of Robert Johnson, and he has used his version of it, which ran on a Unix system, and that system is now just about dead. But the important point is is it's been applied at all of these sites on a piecemeal basis. You can look at your old slides on this one, but the only thing that I think is really of importance here is the savings that have occurred, like 40 - 80 percent sample reductions, 30 percent, 50 percent. Costs going from a $40 million to an $8 million cleanup effort. These are worthy of taking note.

The NRC, we will be talking about one particular little site that we're using as a test site. It's called the Kiski site. It's a very small little sample of data, but it was outstanding. We found out that we could have reduced the number of bore holes by 70 percent on that site, and at the same time reduce the sampling by 85 percent to get the same result. We'll go through that. We've got one we're starting to play with now just a little bit in the SADA framework, and that's Sequoyah Fuels. The interesting thing about Sequoyah Fuels is it's had so many holes poked into the ground that the underground -- the groundwater patterns have changed due to the holes.

We see the potential applications of SADA beyond decommissioning-type activities in the area of early site permits. A lot of sites are going to have to reevaluate where they're going to have to put down wells up close, and there isn't any other code around or any other techniques around that is going to be capable of doing this without an incredible amount of expense. It's going to also assist, I think, in the operating license evaluations that are done, re-licensing, and to some extent partial site release.

The big issue is to, when you get into this, is to understand what the requirements are that you are going to be having to apply. A lot of people will go out and say `Just bring me some more data and we'll take a look at it.' Know why you're collecting the data and what you're going to do with it. And at the same time be sure that you have a feel for what the uncertainties are, and how much uncertainty you can stand. That led to this sequence that has started here. In August 2000, a document came out by MARSSIM that was a combination of DOE, EPA, NRC, the Air Force, other parts of the Department of Defense, and it began to tie together sampling uncertainties and so forth based upon a two dimensional plane, going out, taking surveys on land down to about 15 centimeters, since that's where most of the dose modeling has been. In that process, one of the things that you got into was having to take a look at the instrumentation. How sensitive were you going to have to be to make measurements, because the more sensitive your instrument the fewer samples you could take. You could go out with a Coke bottle if you wanted to and throw it on the ground, see if it turned brown in the morning. That takes too long if sensitivity isn't there. And MARLAP took care of the instrumentation side of it, and the laboratory side of it. And I think this is probably one of the finest documents that has been put together in a long, long time.

Currently they're working on the materials part of it. They're calling it MARSAME, and they've got it targeted for publication around 2007, sometime in there. Talk to somebody else about that. We have the subsurface one coming along. I am going to just call it MARSSub since it's easy to remember, subsurface. I prefer this one to BINMAR map, but never mind. And then we're using SADA to begin to answer some of these questions. We find that by the time we turn it over to the multi-agencies for review and so forth, if they have not been involved with the development, that a little bit of time is taken. But to review it, if you are familiar with the MARSSIM process, and the EPA, things like data quality objectives, knowing what you're going to do, why you're going to do it, what accuracy you're going to need in like data quality assessment. You start out with the DCGLs. You go through all of the modeling, like you may run into with RESRAD, and you have various components, survey units, release criteria. I think that's probably relatively self-explanatory for you.

An example that MARSSIM had, or came out and had an impact. There was a document out there at one time called 5849, which said go take a survey point every five meters across the site that you are working on. Here's some examples of what might have happened. RESRAD, for an example, will take a 10,000 square foot area and model it. To do that, you would require something like a thousand samples. Football field, everybody can pretty well relate to that. That would be here. And you would need about that many samples to do, let's say, something like a football field here, around a hundred samples to sample an entire football field. What they didn't take into account was the sensitivity of the instrumentation, and how far away from your action guide that you were. The further you were away from the action guide, and the better your instrumentation was, a value called delta over sigma, which is distance from the action point, and the variance of the samples you were taking would get larger. And so you could get exactly the same result. MARSSIM suggests to get around, a delta over sigma of around three. Look, we're only taking around 10 or 12 samples to get the same result with the same confidence that you did when you were taking a hundred. That paid off, and that has paid off on several sites big time. There's -- I just covered about an 8-hour lecture.

Sampling in the subsurface. When you get down below the 15 centimeters, some things begin to happen to you. Bingo, you lose the ability to scan. You can no longer take a meter and walk over in the way that we think about it with radiological things. So we had to find a way to design the survey, make it more efficient, and be sure that we didn't have any hidden assumptions. By the way, through a few of these I'll be just talking to the yellow points. I assume you can read the other stuff.

So the research areas that we're involved with right now is, a lot of it is dealing with optimization. Time and effort, which eventually boils down to cost. Want to improve the survey design. We're using site knowledge now, which is leading us into a Bayesian type of analysis. Take the information that you have now or in the past, and can it be applied to what you are doing. Is there any relationship between it and where the contamination might be. In some cases yes and in some cases no. Improved analysis. We're getting into geostatistics. In the area of geostatistics, most of you are familiar, or may have at least heard the term variogram. What it is is a -- I'll show you one later. We have the same thing occur subsurface. We have, let's say an elevated volume. In MARSSIM we were talking about the area, we had an elevated area. They both kind of have the same relationship and behavioral components. How are we going to get around all this? We're going to start using more and more surrogate data, and professional judgment. One of the things that a lot of the licensees got very upset with when MARSSIM started to come out is that their feet were being held to the fire on a design for a survey, and they didn't want to tie everything up on that one particular survey. They said, well we'd like to go out and look first. Well, the response was that's what's going on during the time you're doing characterization of a site. When you come to the final status survey, we want to be able to go out there and apply our statistics to it. So with taking things like Bayesian and some of this, a little bit of this is going to be able to be relaxed just a little bit, and we're going to be able to probably get better results.

And reducing the number of samples is the big issue. Once you get into subsurface, it really gets out of control. Again, increase the information that we're getting from historical data, other geological data, and make more efficient use of the hard data that you have. That's numerical data that you can take and plug into a code. So I mentioned that.

One thing that is important is not all locations are going to be equally informative. When you go out and you do a random survey, you're not going to be getting the same information from those spots. Even if you have secondary information, you're going to have some areas where there may have been things like oil spills that are going to affect. You may have different geology. And that's where the geostatistics and geophysical information can come in and be used.

Okay, now we're going to run through SADA in rather rapid fashion. It has all of this pretty well built into it. We will touch on each one of these topics briefly, but it might be interesting to note that it has been supported by both the DOE and the EPA, and Version 3, which was about a year and a half, two years ago, had 11,000 downloads worldwide. Since January of 2005, when 4.1 was noticing to come out, we've had around 4,000 downloads. Now, that doesn't mean there's 4,000 people out there using it, but this is people that have actually logged on, I've got their email location, and date and time, and when they downloaded it, so we know who, where, and believe me it's worldwide. Side point: if you go to the website of SADA, which I think most of you can find relatively easily, go to the bottom of the homepage and there's a little number off to the left. Click on that number. It's a counter. It'll bring up such things as where it's been downloaded to, how many hits there have been on a site, from where in the world, and it's really been quite useful and informative.

Okay. Graphics. This has increased quite a bit. We can overlay GIS overlays now. And we're to the point where it really doesn't matter where these come from. They can come from AutoCAD, they can come from any -- Earthvision, what's the other one, Arcview. These are all can be moved back and forth. In any event, your data, you can take a spatial data screen, look at your samples. You can pick out samples with given compounds if you wish, or levels that you're interested in. Survey units, this has been a big thing in MARSSIM. You can draw polygons around what you are going to make as your survey unit, and you, at the time when we talked to you the first time they were just getting started on this. We've gotten to the point now of where polygons can be drawn around all the survey units at once on your site and you can do comparisons.

Visualization. This is what we had when we talked to you the last time, and the camp that -- showing a transparency through a thing. We've now got it to the point of where they can do all the neat slice and dice and cube. One of the important things with SADA is to present the data visually. That's its primary function. Keep the math, the science inside the machine, inside the process as accurate as you possibly can, and present the data graphically. You can get a lot of times much, much more information from a graphic than you can.

Okay, statistics that is available within it is overwhelming. There's univariate statistics that pretty much anything from mean, standard deviation, variances, a whole laundry list, histograms, all sorts of formations of data. You have the ability to identify your analytes that you're working with, detects the means, variances, pretty much all that type of information. And for those of you that have a little twinge into the EPA area, this thing is tied to the CASS database. In fact, that's where we're putting a lot of our stuff.

MARSSIM's in there now full blown. I'm not going to go through this, but what it does is as you go through MARSSIM, you are going to do things like select your DCGL, come up with number of samples, whether there's material and background and so forth, and the key is that as you go through it, it's going to tag whether you have completed all of that particular protocol as needed. Did you pick the right sensitivity of an instrument? If you didn't, it's going to bounce you and you'll have a little red dot out here. And it'll tell you exactly where to go to fix it. The layout of the SADA code is very, very much like your income tax program TurboTax. In fact, if you go on and start to use it you'll see an incredible similarity. The outline will come down in the first block, you'll do it, it'll bring out the information that you need, and keep it as you go on through. If you forget something it'll let you know.

This is just going through some of the detail of MARSSIM. I don't think we really need to do this. This is a sign test. You had 18 samples required. They were using a Level 3. It bounds out the so-called gray region that you're going to be interested in. You're getting into, if you've got stuff in background, where you've got it in your sample and in your background, then you're going to go to a Wilcoxan rank sum test, and in that case you're going to have 18 survey units in your unit and in a background area that you're going to do a comparison on. So all the aspects are in there.

In the spatial analysis side of it, most of you are familiar with things like contouring, where you may have had a point here and a point, and you're going to try and find some position in between that you want to kind of draw an isodose curve. We do this also, but a little more sophisticated, and with a little bit more backup. I wish I could spend more time on what's going on here. Is there anybody that doesn't know what a variogram is? If not, see me. I've got a little quickie thing. I've got a whole presentation on variograms, it's about like that, but what it is, there's a point down here that's called the nugget. This is where your first point is. And immediately around that point there's a lot of variability. So a lot of times this doesn't go through the point. Then you have the range. This is the range of where you have your variance. And then you finally have a sill. That's the end of it. That means that any information here, data that you have here isn't going to influence this over here. Data from here might influence that one from there, and that's what's going on in between. The better correlation you have, the slower the slope of the curve, and the further you can look down. So when you start looking at things like underground water movement, or material running on the ground and moving, you'll see a correlation. Let's say if there had been a flow this way, these all kind of seem to be related, and this'll turn out to be like this. If you go the other way, boom, this thing's going to go up and flatten out. And so we can put that into an estimation of it. And from that we can reprocess and come out and say, okay, where are the areas of uncertainty. We know there's no problem here. We're pretty sure we have material here, quite comfortable, and this is the area that we're uncertain about. So you start getting involved in determining the area. This is kind of like the latest -- one of the later things that we just got into it. It's called a rose diagram. What it is is a color version of a variogram as you lay it down on a -- I don't know if anybody has ever generated a variogram by hand, but it is obnoxious. There is a lot of data that goes -- you have to take every bloody point on that site and process it, and then go to the next point and relate it to all the rest of them. And this goes on and on. And then that's usually in one direction. Here we've just rotated the thing all the way around. Under the -- so you have the processing, so you have a variogram which is equivalent to let's say a line through here. For example, here you have one that went up and dropped off. That would be a point -- okay, I'm sorry. As it goes on up higher, this is a bad fit. You don't want that. You have more of a relationship if the variance stays fairly low over a long distance. Okay.

We've built into SADA since we saw you the last time something over 21 sampling scenarios that are now available. You have the basic ones that everybody's familiar with, judgmentals, random, grids, variations of grids. Depending on who you are, you will select them. We have the MARSSIM design in there obviously. But we get into the situation of when you get ready to re-sample, going back in, taking a look at something. Then we have secondary sampling designs where you may go to the area where there was the highest variance, or you go to someplace like adaptive fill. Hey, we had a random thing, but there's an area in here we could take one more sample. It will calculate the best place for you to do that. The high value, and this goes on. Judgmental sampling. People like to use this on occasion. It has some pros and cons, but along the road is a real good example. A MARSSIM sample across this might not be that informative. Simple random. That's more like your MARSSIM.

Okay. Life is good until you start going down underneath into the ground, and you start wanting to -- how are we going to talk about 3D? What I see here, they call it 3D, I call it 2 1/2D. You've got stuff on the surface that you take. Okay, that'd be like MARSSIM. But now you're starting to go down, and you start placing your point of your result of which you're wanting all this whole area to be equivalent to. This is where people start homogenizing cores. And you can move it, and it'll assign values. I call that 2 1/2D. You can, this is in place now. What we're working on now is being able to take core scans.

And when you start going into the third dimension, go back and think about that variogram, and now start putting it into the third dimension. That is going to really be an effort. But we've got a real, real good start on that. Searching for a hotspot. We have a program out there called Elipgrid, which determines how big of an area you're going to miss when you take samples over a long period of time in a given area. And we can now apply it to subsurface. We can put all sorts of little shapes down there that are standard, and look at what the probability is that you are going to hit or miss it. And this is where things like magnetometry, and some of these other concepts come in, because they can really narrow some of this down for you.

We can customize the criteria. You can get data, bring it in from regions, states, locally, and you can have all that data available to you, and bring it in, and process it, and relating it to what you're working on. There's a human health risk calculation in here, complements of the EPA. See, EPA funded this thing to the tune of, I don't know, several million dollars before we got a hold of it. And they've got all of this type of information in here, and there's a couple of sets of that. There's one slide in cutting the presentation, making it a little shorter. I had to cut one out that had kind of a cute little picture. Okay.

So from that you can develop things like health risk maps. Same thing on the radiological side of it. Where the risk is going to be the highest you can -- you have a site, you have areas where there's contamination on it, you can determine what the risk coefficient is going to be in various components on a particular site. We had points that were identified early on to take a look at.

And to decision analysis. This is the one that I think is probably going to be used quite a bit. You take the data, you have your various sampling strategies laid out. From these you can get spatial screens, and you can come up with risk based on space. Areas of concern. This is going to be areas that you might have to clean up. And we're working on techniques of minimizing this area. We've got some in there now that are quite good, but you can assign what is it going to cost to haul out a cubic yard, or X number of cubic yards of material. And we've got a little risk curve here that will -- risk/benefit that will tell you exactly what it's going to cost you to clean that site up so you can use it in the estimation area.

Geobayesian modeling. Making use of soft knowledge, soft information, and combining it with hard data. And we fall into the area of geobayesian modeling. Ordinary kriging and indicator kriging are generally based on normal or log normal type distributions. Indicator kriging is the one we're finding more useful. We are having more and more luck with the application of non-parametric statistics because from our standpoint we really don't know what the distributions are when you walk into a site, and sometimes you never do. And we've found that through MARSSIM, that any errors that are made by using a non-parametric are usually almost unmeasurable. And people talk about modeling.

Let's talk a little bit about the Kiski site real quickly. This would be a prior knowledge type curve or plot that you would make. In fact, you actually sat down and said, there's X Y, and you drew a line here, and you said okay, everything inside here, we're pretty sure there's something there, and 90 percent sure there's something here, and I'm pretty sure there's nothing out here. This particular range, I really don't know whether there's anything there. Now we're beginning to play some of the Bayesian game.

So, there's where judgmental sampling would come in on something like this. You've got these sampling plans that you can use. But what happens is we're going to go around, we're going to try and take a few samples around this area of concern, some inside and some outside, just for confirmation. This is what the original data set looked like. The guys when they started on this didn't have this information. I asked them what they wanted, and we would provide them the data, and we would pull it out of the data set and give it to them. But, there were 1,261 samples in the shallow sediment, and they took over 90 boreholes was what had been done. And remember I said that we reduced the number of samples by 85 percent, and the number of boreholes by probably 70. And so this is what it all kind of looked like. And this is looking at it that way, and of course through the side. So what we're going to be looking at as we go through here is the analysis that's taking place at various layers. Okay.

From the judgmental sample, what we did is from that we went and said, okay, where is the closest real data point of a real data value they could use. We didn't want to go out and sample again. These red points show above the action guide, the blue points below the action guide. This is on the surface. This is down around six inches. A little bit deeper. The red points are showing, again, above the action guide and those below. There's 130 total samples taken. And these were ran on each layer, and we came up with the variogram prior correlation model that came up and then began to drop off as you moved out at the end. And here's kind of what happened. With zero samples, yes, 0.6, 1.2 and 1.8 it looked like that. Did the sample analysis with 130 samples, and here's what the distribution looked like at the various levels. We doubled the samples. Let's go to 260 samples and see what kind of a change that would make. And a little, but not very much. Probably, depending upon the cost of the sample and where you'd want to do it. And then with all 1,260 samples available. Now, by being a little bit careful on where you took the samples and how you did the analysis, we think we can probably get by in this particular case with an evaluation of probably around 130 samples. When you're looking at the total impact there would be on, let's say material that might be left behind.

These are the areas of concern that came when we did the area of concern by looking at what percent of the areas above a given value. And again, there's not that much change between 130 to 1,260. There's a little larger area maybe, but not enough to spend another couple of million dollars. The metrics on this. This is the area of concern volume versus sample, number of samples, and the volume that you would let's say have to remove, which I was talking about. In 130 samples, Y around 2,000. 260, yes it went down some, and at 1,260 a little bit more. This becomes a weigh, do I want to or don't I. We have a percent change with the number of samples that we were involved with. And finally, the thing that we would be interested in, the percent that we would have missed. And after 130 samples there, the 130 sample things still look pretty good. Okay.

That brought up another interesting thing. This is using a geobayesian analysis. What had happened had you used something like your indicator kriging, the everyday analysis that people use, might use. This is the comparison between the two. The question comes up, now remember, indicator kriging's only going to use the data that's there. Either it's there or it isn't. Bayesian's going to start, and geobayesian's going to start making some assumptions depending upon what you've told it. So it doesn't drop off to a nice clean thing here. In this particular case I would have a tendency to recommend that you might want to kind of compare these two together in reality, just to make sure that things are still pretty close. Let me give you an example. There's a really good concept. You've really got the model right. And then you went out and you took your samples. You got a nice clean variogram, and your model came out looking pretty good. And that when you analyzed this number of samples. Let's say you made a real bad guess. Now you're going to see where Bayesian -- nothing's free. In the case of the Bayesian, here's your estimate, and here's your real data points. Here's somebody let's say trying to -- well, we don't have anything here we're going to sample, and wind up taking a few samples there. And their analysis comes out looking like this initially. Says whoa, whoa, we've got some points up here that are -- look clean, and we've got this area starting to grow here, showing contamination. The impact of this is that you got to this solution let's say with 150 samples. With 150 samples from this one you're going to get something that looks like this. To take enough samples to convince the Bayesian analysis that you're right, you're going to have to take 800 samples. So when people begin to use Bayesian analysis, a lot of care has to be taken in what they are going to use as their priors and their assumptions that they make. Like we're saying we don't want any undefined assumptions. So from our standpoint that's kind of good.

That pretty well covers it. However, I've got some slides you may or may not have. We've got the layering now so we can break it up into solid pieces, individual pieces, and we're starting to work on the third dimension of the kriging. We're getting further and further into the correlation models. That's where you start getting into things like cokriging, covariance, statistics of statistics, if you want to look at it that way. Here's a good example that Pierre Goovaerts pulled out. We do how to study here, or workshop here sometime ago, and this has been a real good example. Here you have rain data. Let's say you go ahead and do indicator kriging on rain fallout, looks like might come down looking something like this. You have another group of data, let's say by elevation. That would be a little mountainous area. And you combine eventually the data from the elevation and the data from the analysis of the rain, and you get a combination of how those two would fit together. And surprise, surprise, your rain is occurring in the higher elevations, but you're not stuck with this big mud ball, or big large area. It begins to define it a little tighter. And this is the effort that we're getting into on this next part of this project, is to be able to do this cokriging analysis, and covariance analysis in three dimension, and using additional data.

Now, I may have some slides you don't have. One of them being informed Elipgrid, getting into the subsurface. And we've mentioned that we've done things like we have lost the ability to scan unless we use something else. So we can't go out with a survey meter again. We're going to go out with a magnetometer. We're going to go out with ground-penetrating radar. We're going to look at the old plans. There's a trench here. Everything.

Another one might be or is geostatistical stimulation. We're bringing some people in from North Carolina on this. And it'll hopefully take -- what it does in short is it takes data that you have, processes it, assumes that's the starting point, and continues on for awhile until you come to some sort of a continued realization. There's not enough information to -- I don't understand it quite enough yet to get into it too far.

Another one that is quite useful is the concept of your ground-penetrating radar, and a few other things. These are the items that we are looking at for big gain, able to set up cokriging, co-analysis, to get a better handle on where the location of contaminants are. We can now -- or are working on getting photos to drape over the analysis area. One of the problems that we've got right now is if you have something with a mountain on it and you start slicing it, it gets extremely difficult to do the kriging and so forth on these sites because you have a little slice up here. But now we're trying to build it in so you can handle the surface geometry, which is going to be really important when you start getting to the underground configurations of the soil and so forth. There are codes out there that can do some of this stuff far better than we, but we've found that we can probably do -- have a much broader variety, and it doesn't cost the licensee anything. Some of the codes out there cost several hundred thousand dollars a year. In fact, SADA's being looked at by some of the oil companies. In fact, it has been used in South America already for a little bit of oil exploration on simple core analysis.

That's -- you've seen the variogram 2D.

We're shooting to go 3D. And we're looking at that one as being really lots of fun because you don't have to go very far to have variability, a lot of variability in a short distance. And especially when you start taking -- well, that's just pretty much it.

This is in case some of you are wondering what Sequoyah looks like. Does anybody remember how many wells there are? All those black dots are a well, or a hole, or a sample point, or something like that that was a core. It's well over a thousand I'm told. And it was sufficient to change the groundwater pattern on the site. And we don't want this to happen, or I don't want it. That didn't seem like a very good approach. There's a lot of historical information and new information now that can be used. At the time, probably not.

And I believe that concludes my presentation. These were the ones that were dumped out. Thanks Ruth. We have a giant help file. We had a big long list of all the detail. Okay. All right. That's it.

MEMBER WEINER: Thank you. Ken?

MEMBER CLARKE: I do have a couple of questions, and maybe you could put that website back up again at some point so we could get it. But I didn't see anything that indicated that this package couldn't be used for both radionuclides and chemicals.

MR. POWERS: Oh, it's used for all of it. If you look at the --

MEMBER CLARKE: You have the EPA databases, IRIS and --

MR. POWERS: Yes. My advice to you is to go to the user's manual on the website. It's unbelievable. It has all the chemicals in the CASS database. It has -- radionuclides are almost a side note in it.

MEMBER CLARKE: Okay. Can you take us to the -- you had two health effects calculation slides. Can you take us to those? I don't know what numbers they are. They were kind of in the middle.

MR. POWERS: Yes.

MEMBER CLARKE: The ones that referenced -- well, let me just ask the question. You would go to the EPA database for the toxicity factors, the slug factors, the reference doses, and then you could select a pathway.

MR. POWERS: Right.

MEMBER CLARKE: And then you would construct and expose your pathway. And then you would construct and expose your scenario. The risk assessment then, can that be done probabilistically as well as deterministically?

MR. POWERS: Yes. It's done in the EPA world. We're taking all of our dose calculations and everything from things like RESRAD. Like one of the features, or one of the things that we need is the thing known as the area factor, you remember? For radionuclides. Well, we can actually take the little spreadsheet that comes out of RESRAD and just pump it into here, and run through it. The EPA has been handling the chemical side of it. I didn't want to, you know, suggest that -- or spend too much time on it.

MEMBER CLARKE: Sure. Just to get to the bottom, I just -- we can construct different exposure scenarios based on different types of land use, and we can do the industrial versus residential versus recreational or whatever. If we were looking at a, you know, a particular future land use given that data. And you could do the risk calculation either deterministically or probabilistically.

MR. POWERS: Again, the human risk assessment part of it has been set aside and is handled in the EPA form, and has been tested and validated for their use. We have not jumped into the risk assessment because there is so much going on in this agency on ICRP, and a lot of it just, you know, we're trying to stay as far away from politics, I'm sorry, as we can, and stay as technical as we can. How they use it, you know, it's something else.

MEMBER CLARKE: Okay. And you'd said there are reports, additional details that are available that would be mentioned on the website?

MR. POWERS: Right. Yes. Let me see if I -- I'll tell you the easiest way to get to the website. Do a Google search on "SADA EPA" and when you see something that says TIEM, which is University of Tennessee, go there, hit their homepage, and you're in.

MEMBER CLARKE: All right.

MR. POWERS: The website is too long. I can't even remember it.

MEMBER CLARKE: Okay, that's good advice. Thank you.

MR. POWERS: Right, yes. And the -- we're getting a lot of information, and the books that we're using, or the information that we're using that's available to everybody. Probably some of you have seen this, but this is a good one to get started on. It's a nice little elementary book on geostatistics.

A lot of the initial code came out of GSLive. So we've tried to keep everything that has a very good pedigree behind it, and a lot of this has gone through a fair amount of modification. And for those that are up to abuse, there's Kressy's book, which is -- probably he and two other people in the world can probably read it and understand the whole thing in detail. But the one that we're focusing pretty much everything on is that by Pierre Goovaerts. He's been here, and he's going to be working on this next phase of it to some extent.

MEMBER CLARKE: Just one more quick question, just to clarify. The cost savings that you referenced where using this approach you could reduce the sampling cost by 40, 60, 80 percent, I assume that was within the same sampling program design as conducted originally. In other words, you didn't reduce the cost by going to a different design.

MR. POWERS: Now, a lot of these were fuse rad sites which had both chemical and there was an initial design as I understand in most cases put together, which was like a 58/49 type, every five meters, something like that. And then they got into the adaptive sampling aspects of it. And Robert Johnson was able to through this process reduce it.

We do have a little bit of a tweeky problem with the process, and it deals with when you're taking the one set of data, and going to put it with the hard set of data, when you go to calculate what the data value points should be at a point where there is a data value, the closer you get to it once in awhile you'll go into a negative correlation which just makes no sense. And so we're futzing around with that a little bit.

MEMBER CLARKE: Okay. Thank you.

MEMBER HINZE: Dr. Powers, you've covered a lot of material here in a very short period of time.

MR. POWERS: About 10 percent of what there is.

MEMBER HINZE: Well, let me ask you a question. It seems to me the SADA is really focused, as I've understood your presentation, on increasing the efficiency of surveying and analysis and to capture and evaluate the uncertainties in the measurements. How, is that approximately correct?

MR. POWERS: That's pretty close, yes. We're trying to optimize sampling where the least amount of information is needed to get the best result. Initial part of it is to visualize the data that you have. I consider that almost in some cases as important as the analysis itself, because a lot of times you can look at something and come up with a solution that you probably wouldn't be able to do mathematically. But the mathematics is there is important.

MEMBER HINZE: That's right. How do you capture the uncertainties in the studies that are being made? For example, you showed us this GPR work. There are multiple interpretations of that.

MR. POWERS: Oh yes.

MR. PALM: Some of them are more credible than others. How do you capture the uncertainty in the interpretation?

MR. POWERS: The linkage between the things that are going to be doing covariance on and cokriging on is our next step. We're fully aware of the -- of how do I know what percent of this data is going to apply to this.

MEMBER HINZE: But there are uncertainties too simply in surface measurements. For example, most of the surface measurements are integrated with GPS for station location, for positional data. And there's uncertainty in those. How is that captured in all of this?

MR. POWERS: As far as location -- no,

that's a good question because we don't. I mean, we're starting out with samples. We're assuming that they've put the samples where they say they are. But I think you -- depending upon the amount of error that you have it's going to have an impact let's say in that particular case on things like shift, or. Hopefully the site that you're working with is going to have data that if you are off a little bit it's going to be irrelevant, or you know, the cliché is close enough for government work.

MEMBER HINZE: Well, you mentioned the use of individual judgment. Do you provide -- does any of this provide guidance on that?

MR. POWERS: That's what we're pulling together during this next part. We're hoping to have available within probably a year or a year and a half a NUREG where we're starting to get some of this stuff together on. In fact, if you're a biologist or a zoologist or somebody like that, you're familiar with binary classification. That's kind of the approach that we're going to take when you walk into a site of where you're going to start making a series of choices. And to determine what the error is that you're going to be required to handle. You're going to have to go in ahead of time knowing how much error can I tolerate, and then you start looking at the systems that you're going to use, and hope that they get in there so you don't get into that situation of bring me another set of data and we'll take a look at it.

MEMBER HINZE: Thank you very much.

MR. POWERS: Yes.

MEMBER WEINER: Are there any burning staff questions? We have a few minutes. I don't want to cut into the next speaker's time too much.

MR. HAMDAN: It can wait.

MEMBER WEINER: Okay. Anyone in the audience? No. Then thank you very much. And I'm sure if people have questions they can come back to you.

The next speaker is here. I understood Michelle Sampson. Oh, there you are. Good to see you. I'll give George a chance to get all his vast data sets together. Our next presentation is by Michelle Sampson from the Federal Railroad Administration on the use of dedicated trains for transportation of high-level radioactive waste and spent nuclear fuel. So welcome, Michelle. It's all yours. Oh, sorry. He walked away with the mic. Do you want to use this?

MS. SAMPSON: I'll just use this. I'm Michelle Sampson, and I do work with the Federal Railroad Administration. We're one of the operating administrations from the Department of Transportation, and I am pleased to be here today to talk with you about our dedicated train study. The title of the study I believe Earl was able to provide a copy of the report to Congress to you. It is Use of Dedicated Trains for Transportation of High-Level Radioactive Waste and Spent Nuclear Fuel.

The first thing that I would like to discuss is a little bit of the history of the report. And I have to apologize to you right now. The expert on the history of this report is Kevin Blackwell with our office. He's been intimately involved with this report since its inception, and could probably answer any question about the many perambulations and changes that the report's gone through off the top of his head. I only joined the Federal Railroad Administration about a year and a half ago, and am not as familiar with the history of this report. As you'll see in a moment it's been ongoing for quite some time. I will do my best to answer questions for you. In the event that I don't have the information with me I certainly will take that information down and make sure that we get back with you to provide an answer.

One of the keys to understanding the report to Congress is to know a little bit about the study methodology, some of the assumptions and decisions that were made at the outset, and how those impacted the study findings. We'll discuss the study findings, and then just briefly I'll talk with you about Federal Railroad Administration's path forward now that we have published the report to Congress.

As I mentioned this has been a process that's been ongoing for quite some time. The study was mandated by HMTUSA 1990. That public law had two specific requirements. It required the Federal Railroad Administration to perform a study that would compare the safety of dedicated trains to other methods of rail transport. That was due to Congress in November of 1991. It also required the Federal Railroad Administration, once the study had been completed, to take those findings into consideration and review FRA's existing regulations for safe rail transportation. We're a little late. Funding for the study was not appropriated until the spring of 1992, and at that time Federal Railroad Administration identified VOLPE National Transportation Systems

Center as a partner to assist us in preparing and conducting this study.

The study really was kicked off with a 2-day workshop in Denver, Colorado in September of 1992. That workshop was attended by representatives of potentially affected stakeholders, states, Native American tribes, the railroad industry, shippers, potential shippers of spent nuclear fuel and high-level radioactive waste. It was also attended by representatives from the Department of Energy and the Nuclear Regulatory Commission.

Utilizing the products of that public meeting, a first draft report was generated in February of 1993. That draft went into a review process within the Department of Transportation. Comments were provided to VOLPE. The VOLPE centers provided a series of revisions and updates to that report. The report has also been coordinated with the Department of Energy and the Nuclear Regulatory Commission. There have been several meetings between the departments to discuss the report, and get input from the experts within Department of Energy and Nuclear Regulatory Commission to assist us at FRA with our report.

In 2001 and 2002, a significant effort was made to update and revise the early 1990s report, and as we began to look at some of the assumptions and some of the findings of the report you will see that it does incorporate data through 2001. So it was significantly updated and revised in the interim. And at FRA we did publish a final report. The report is dated March, 2005. It was actually transmitted to Congress in September of 2005.

I mentioned understanding a little bit about the study methodology. The report to Congress that you may have had an opportunity to look at talks in some general terms about the study methodology, but there are a lot of basis and assumptions that affected that that are not fully discussed in that report to Congress. The study was required to do comparative analysis. We did comparative analysis on three specific types of train service, regular trains, which would be your general freight consist, key trains. That's an industry term for a train that is identified as hauling specific quantities of certain hazardous materials. The key train concept actually is a large part of the 2001 revision. As we begin discussing the key train you'll see it's based on a 2001 Association of American Railroads industry standard. And then of course dedicated trains. There's also a standardized cask prototype, and the details of that cask impact the outcomes of the study finding. And a decision was made that representative routes would be selected and used for comparison.

I mentioned the first type of service that we reviewed was regular train service. Those are general freight trains. They operate at allowable freight track speeds, make numerous classification yard entries for making up the train, and certainly would haul other hazardous material freight along with the cask consist. Those trains are subject to the hazardous material regulations and of course FRA's rail safety regulations, but there were no other limitations or operational controls put on those trains. The study modeled regular train service as a generic 70-car train, and the cask consist was modeled as being directly in the middle of this train. One thing that I would like to note is that's the way it was modeled. In actual regular train service, the weight of the cask car and cask consist, train track dynamics would make that a poor placement for the best operation of the train. The optimal place would be near the front of the train to improve the train track dynamics and fuel efficiency of the locomotives. But it was modeled as being directly in the middle.

Key trains. We incorporated key trains based on a 2001 Association of American Railroads recommended practice circular. I've listed that here. That circular's been updated by the industry since 2001, and has had some minor changes, but the key train that was modeled was based on the 2001 circular. For our study we determined that the only operating restrictions of the AAR circular that would impact our train was the speed restriction. In the operating circulars, trains hauling these specific hazardous materials are restricted to a maximum of 50 miles per hour, regardless of the authorized speed on the track. Other than the speed restriction, the key train was modeled as having the same length and configuration, and going through the exact same operating environment, the same number of yard entries, same passing restrictions. A key train would certainly be expected to have additional hazardous material freight as part of the consist.

And dedicated trains. In the study, dedicated train was modeled as a 6-car consist, two locomotives, two buffer cars, the cask car, and an escort car. In the discussion, all of the results and findings of the study are based on one cask car transportation. The operational limitations for the dedicated trains. Speed was restricted to 50 miles per hour. The dedicated train was assumed to be under a no passing rule which means that on mainline track, either the dedicated train or the other train would be moving only one at a time. The dedicated train would have priority to pass, and we would expect other freight consist trains to be standing still. That impacts the probability that the trains will hit each other in passing, and so the no passing rule is a key operational limitation. Also, because the key train does not have other freight cars, it would limit visits to classification yards. The number of yards that the key train would pass through would be reduced somewhat. The primary reduction is in the amount of time that those cars would spend in the classification yard because they would not need to be switched. They could pass through directly.

The cask description. As the study was envisioned, the number of casks and the availability of information on spent fuel casks that might be available, spent fuel and high-level waste casks that might be available, was more limited than it is now. At the time that the study was developed, the cask that was selected to be used for the study was 125 ton steel, lead steel, prototype cask. One thing that the report to Congress does not really make perfectly clear, both the technical study that supported that report to Congress, the NRC's cask certification criteria was established as an upper bound of the functional strength of the cask. That has certainly been a controversial decision as the report has gone through its reviews, but it is important to understand that that's a decision that was made up front in the way that the study was developed. In addition to those certification criteria, VOLPE and the FRA utilized Sandia's report, the NUREG 6672 which was a study of this cask prototype without impact delimiters, and that was used as input for the rail crash analysis. So those are important factors for how the report itself was developed.

I mentioned that the study is designed to be a comparative analysis. In order to do some type of comparison, the FRA and VOLPE needed to have some shipments to evaluate. A decision was made. Six routes were chosen. The origin points were selected from existing nuclear power plants and high-level waste repositories. The destination point selected for the study was the Yucca Mountain facility in Nevada. The goals of selecting the representative routes were to utilize the major east-west rail links, and to select representative geographic locations and links for the transport itself. Those specific links, exactly how rail traffic would travel from origin to destination were determined using Oak Ridge National Lab's inter-line routing model. And those were just based on a most likely traveled route. There were no additional routing decisions incorporated into that.

This is a little small but not too bad. These are the six routes that were selected. Obviously the origin points are identified there. You can see the length in miles from that origin point to the selected destination facility. The population data for those routes is based on the 2000 census. That was updated in 2001. Just to note, the Routes 1 and 6 are the shorter routes, and Route 5 is the longest route. As we began to look at some of the findings they're listed by route number, not by origin.

Utilizing those inputs. That's the basis for the study. The study itself performs a comparison of the radiation dose risk for each of the six routes under incident-free transportation and under identified accident conditions. In addition to that risk comparison study, the FRA began a preliminary consideration of operational safety. And the report to Congress also incorporates those operational safety considerations that were identified by the FRA.

Our incident-free transportation comparison was calculated using Radtran with the assistance of Sandia National Lab. It took the six representative routes and other inputs that were decided and selected. The cask dose rate was assumed to be 10 mrem/hour at one meter. That does correspond to DOT's non-exclusive use limit. It does not correspond to any data on shipments that have taken place. It was simply selected as the cask dose rate that would be used for the study. The consist description, again I mentioned, 70 cars for a regular key train, and a 6-car consist for the dedicated train. That was input into Radtran along with the service type and speed limitations, the impacted populations from the 2000 census, and shielding factors for the type of area that the train would be traveling through, urban, suburban, or rural.

The results of the Radtran analysis were expressed as population dose and person rem. And those were converted into latent cancer fatalities utilizing the conversions of the NCRP report. We looked at those results and evaluated them by route. They're also evaluated by service and speed for comparison of dedicated train to regular train service to key train service. Also, by population type. Populations were broken down into various rail workers, members of the public. And we looked at the population doses for in-transit dose versus dose during stops.

And looking at the accident-related risk, again the goal is to compare radiological exposure due to the accidents in regular service, key train service and dedicated train service. The accident involvement probability, accident severity probability and expected consequences were identified. For regular train service, the study started with regular train service, and three event trees were constructed. The first was for movement on mainline track, the second was for consist movements within the yard and a separate third event tree was developed for fire events. Fire events of course could be an initiating event, or they could be the outcome at any node in the other trees, so they were handled separately. The Federal Railroad's existing Railroad Accident Information System was used to define and categorize those accident types. And the baseline accident probability was calculated for regular train transport utilizing data from 1988 through 2001. The total number of accidents per year was normalized by dividing it by the reported train miles per year for each year.

The accident types that are contained within the FRA's accident database are derailment accidents, collision accidents, and there's a variety of different collision accidents that are tracked, crossing accidents, miscellaneous other accidents, and then the fire and explosion accidents. The accident severity for the mainline and the yard trees. The impact velocity for the accidents was identified to determine probability and severity, and for the fire event tree the severity as based on fire intensity and duration. The accident consequences were described in terms of the cask damage and the resulting radiation exposure.

For key trains, the baseline normal transportation or incident-free transportation event trees were modified to reflect the speed restriction to 50 miles per hour and the improved braking that would come as a result of that speed restriction. The probability for accident -- or the accident type probabilities were decreased only for the collision and obstruction accidents where speed was a factor in the accident, and for the highway, rail or rail-rail crossing accidents where speed was a factor. Those were very minor decreases in the accident probability.

For dedicated trains, those event trees were modified to reflect the operational restrictions of the dedicated train. And as I mentioned earlier, there were significantly more operational restrictions for dedicated trains. The number of yard entries is decreased as is the amount of time spent in each yard, the consist length is far shorter, only six cars for the dedicated train, passing restrictions, the speed limit of 50 miles per hour, and the fact that no other hazardous material cars can be a part of the train consist. Those operational restrictions resulted in significant reductions in the accident type probability for all types of the accidents except for those accidents who are affected by train frequency. Clearly by utilizing dedicated train with only one cask per train consist, you are increasing train frequency. However, the number of increased trains as compared to the total train miles in the United States was so small there actually was no increase in that accident type probability. It had no change.

MEMBER HINZE: Excuse me, if I might. In terms of the operational restrictions, was the consideration ever given to excluding major urban areas?

MS. SAMPSON: Not in this study. We did not look at that, no.

MEMBER HINZE: Why is that?

MS. SAMPSON: Unfortunately that is one of the questions about how the study was set up originally, and I was not involved in those decisions that were made. You may know more about it.

MEMBER WEINER: I can comment on that when we get through.

MEMBER HINZE: Okay. Thank you.

MS. SAMPSON: But no, it was not. The linkage, the route that the train was transported across from those origin to destination points was simply identified as a most likely traveled. It did not take any other factors into consideration.

The accident rates. After the event trees were developed, it was identified that the overall mainline transport accident rate for all of the accident categories and the yard accident rates were virtually indistinguishable for regular and key service. Again, the only operational restriction for key service was a reduction in speed to 50 miles per hour, and that did not make a significant impact on those accident rates. So as we look at the findings, you'll see that for mainline and yard accident rates, regular and key service were combined.

The overall mainline accident rate for dedicated train service was only reduced by about 3.8 percent less. However, the overall yard accident rate for dedicated train service was reduced by 75 percent less, and intuitively you would expect to see that type of a reduction because of the significant reduction in the amount of time spent in classification yards by the use of a run-through train instead of a train that had to be stopped, cars separated, train broken up and then put back together again.

I mentioned that cask damage and dose rate were utilized to identify the consequences. The FRA and VOLPE identified four accident severity categories. Category 1 was identified, an accident that resulted only in delay. That delay event would not result in any dose increase from the baseline dose of the cask, which as I mentioned earlier was assumed to be 10 mrem/hour at one meter. Accident Type 2's were those accidents that could result in a dose increase to 1,000 mrem/hour at one meter but no release of radioactive material. The third accident category were accidents that would result in loss of shielding or internal damage, and the dose rate was anticipated -- or dose rate was assumed to increase to 4.3 rem/hour at one meter. The fourth category of accident would have been an accident resulting in release of the radioactive contents. That category of accident was analyzed to be equally unlikely for all of the shipping -- or was identified to be equally unlikely for all of the shipping options and was not further analyzed.

Dose accident consequences were calculated again using Radtran 5. Doses to the general population, rail workers and emergency response personnel were identified. The findings we'll look at in a moment. A Category 1 accident was determined to result in a 10 hour delay. The Category 2 and Category 3 accidents were looked at over a range of delays lasting between three and 72 hours. The accident comparison is between regular and key service combined with dedicated train service, because again the accident probabilities for -- or accident probabilities for regular and key service were indistinguishable once we finished the event trees.

After the determination of the person, rem and latent cancer fatality findings was completed, the FRA determined that there were operational safety considerations that should be taken into consideration in looking at these different types of service that weren't fully addressed by just looking at the radiation risk of transportation.

CHAIRMAN RYAN: Can I just pick up a little follow-up question.

MS. SAMPSON: Sure.

CHAIRMAN RYAN: I'm troubled by the use of fatal cancer risks. The reason is is it's absolutely incorrect to apply a fatal cancer risk expectation value to an individual dose or to a dose to a small group. The idea of person rem here is meaningless. It's very conservative and just flat out wrong to use a cancer risk indicator for these small groups. So can you maybe give me some insight as to why you did that, or why didn't you just stick with dose? It's so much simpler and more accurate.

MS. SAMPSON: Unfortunately again I cannot, and I apologize.

CHAIRMAN RYAN: Okay.

MS. SAMPSON: You would have benefited by having someone who was more --

CHAIRMAN RYAN: And I don't mean to put you on the spot. I appreciate that, but I just wanted to, for everybody's benefit, point out that these risks of fatal cancers are just flat out wrong. I mean, it's a misuse of an expectation value of a distribution. Thank you.

MS. SAMPSON: Yes. The study looks at a relatively small dose over a very large population, and then does use that to.

CHAIRMAN RYAN: We're on record on several occasions as a committee of pointing out that's just wrong.

MS. SAMPSON: However, there are several assumptions and decisions that were made at the onset of the study that resulted in the findings being what they are, and it is important to understand what those assumptions were because they do affect how the findings of the study came out.

MR. THADANI: Mike, also impact limiters were not considered.

MS. SAMPSON: They were not.

MR. THADANI: So that's significant.

CHAIRMAN RYAN: Sure. And I appreciate that additional point, but it's -- I think it's very important to recognize that, you know, a dose calculation doesn't automatically translate into a cancer risk calculation. It has to be done with great care, and even with -- well, I mean let's leave it at that. Thanks.

MS. SAMPSON: Taking into consideration comments that we had received on this study, and also FRA's review of the study, at FRA we felt that there were operational safety considerations that should be identified in looking at the differences between regular, key and dedicated train service, and that looking strictly at the radiation risk did not fully identify those operational safety improvements that could be realized. Obviously reduced time in transit and switching operations does reduce your radiation risk. However, avoidance of switching and the classification yard is a significant operational safety consideration. In looking at the accident data, a significant portion of accidents do happen in switching operations, and being able to completely avoid switching operations is a significant improvement to the operational safety for the train itself.

You have a reduced derailment and collision potential if you utilize some of the newer technology that's available. The electronically controlled pneumatic brakes that are available could be used on a dedicated fleet of rail cars, and the uniform consist significantly improved the train track dynamics, and braking capabilities of that train, which of course make it far more safe operationally.

Other potential operational enhancements. If you're using dedicated equipment operated in smaller consist you have less wear and tear on the equipment. There would be fewer mechanical malfunctions anticipated for the equipment utilized in dedicated train service. You have a reduced risk from interaction of other hazardous materials in the event of a derailment or collision. The risk analysis -- or the radiation risk analysis took that into consideration in reducing the time that it took to respond to a dedicated train accident versus regular key service. However, the operational consideration there is the increased or improved ease of response to the emergency responders when they're only dealing with one hazard, the reduced amount of time that it takes to clean up a derailment if you have six cars in the consist versus 70 cars or more.

And in addition to the ECP brake technology that I discussed just a moment ago, there are additional potential engineering enhancements that could be utilized. ECP brakes require a communications backbone that links the cars, and various types of onboard defect detectors are being tested, and some are in utilization, and with a dedicated fleet and a small consist those could be utilized quite effectively to improve the operation of the train.

If you have had a chance to look at the report to Congress you will see that the findings in the report to Congress were that the VOLPE study indicated that risk to the employees and the public from transportation of spent nuclear fuel high-level radioactive waste is low, but on a comparative basis dedicated trains appear to offer advantages over general consist. And if you have not had an opportunity to look at the report to Congress it is available online from FRA's website, which I have listed here. Our website is not the easiest to navigate, but the report's available under our safety publications links.

The report concludes that on a comparative basis that dedicated trains are safer. One thing I would like to provide is some of the numbers that back up that comparative basis. And one of the things that's important to recognize when you look at these numbers is dedicated train service is comparatively safer based on this, but the numbers are very, very close, and the numbers are very, very small. I mentioned the routes. Routes 1 and 6 were your shortest routes under normal conditions of transportation those have the lowest total person rem, which of course results in the lowest latent cancer fatalities. That's merely a function of the reduced time in transit. Less time exposed to the shipment results in lower dose rates. Route 5 I think was the longest.

CHAIRMAN RYAN: Just another follow-up question. I have to point out, I can't accept four significant digits. I see 0.1 or 2 as your total person rem, and I see something like, oh I don't know, pick a rounded off number, 4 times 10^{-5}, and I would challenge anybody to prove to me that any of these are different, or any doses are different.

MS. SAMPSON: Yes.

CHAIRMAN RYAN: So I see one number.

MS. SAMPSON: And we'll get to that in a moment.

CHAIRMAN RYAN: Okay.

MS. SAMPSON: No, I do think it's important to realize they are very, very small numbers.

CHAIRMAN RYAN: Well, and it probably misrepresents your level of certainty to use four significant digits. It's just not right.

MS. SAMPSON: The accident findings are very similar. As I mentioned, the regular and key train services were combined in looking at the accident findings. Where you see the R/K that's regular and key service, and D of course is the dedicated train service. For the accident events for Category 1 accidents the duration of the delay event was assumed to be 10 hours. There is some comparative reduction in the numbers for dedicated train service, but again, the numbers are very, very close. For accident categories or event Categories 2 and 3, there is more of a difference, but the overall numbers are still very small.

The issue you just alluded to is really when you look at these study findings, what the study identified is that non-incident risk from the entire shipping campaign. And we based our definition of the shipping campaign on the number of rail shipments identified in the Department of Energy's EIS. It's appreciably less than one latent cancer fatality, regardless of the type of service. That's the baseline finding of the study.

And that is -- oh, our path forward. Thought I was done. That is the finding of the study.

FRA of course had a part two from the 1990 HMTUSA, and that was to determine if rulemaking is warranted. FRA is in the process of developing cost-benefit data associated with the dedicated train study. We're also reviewing the industry operating and maintenance standards that have been published post-study. Quite a bit of work has been done by the industry. AAR has updated the key train circular, which was mentioned as the basis for the 2001 incorporation of key trains, and also have developed a standard S2043 for equipment use for high-level waste or spent nuclear fuel shipments. FRA is reviewing those. And we also are actively interested in and reviewing Department of Energy and industry shipment planning documents. A determination of whether rulemaking is warranted or not should be made within the next 18 months by the FRA. We're also in the process of reviewing and updating our internal safety compliance oversight plan for shipments of high-level waste and spent nuclear fuel to ensure that FRA's internal inspection resources are focused where they can be most effective. And now I'm done. So any question?

MEMBER WEINER: Thank you very much. We'll go around the table. Dr. Hinze?

MEMBER HINZE: I'll pass.

VICE CHAIRMAN CROFF: Yes, I had one question. In reading the report that you're summarizing, if I understood it correctly near the end it basically said that most spent fuel or high-level -- I guess spent fuel mostly right now shipments are occurring by dedicated train right now anyway. Is that -- do I remember that correctly?

MS. SAMPSON: That is the information that FRA has been provided on shipments of spent fuel that have been made is that the majority of them do take place by dedicated train at this time, yes.

VICE CHAIRMAN CROFF: Okay. All right, thank you.

MEMBER WEINER: Further comments? Jim?

MEMBER CLARKE: Just one. Could you back up a couple slides? You had a couple of tables I think. Very, very close to the end.

MS. SAMPSON: Just a moment. Be glad to. Were you interested in the accident table or the non-incident?

MEMBER CLARKE: The final comparisons.

MS. SAMPSON: Okay. This is the comparison of total dose.

MEMBER CLARKE: Yes, that'll work. Actually the next one's probably better.

MS. SAMPSON: Okay. Yes.

MEMBER CLARKE: Okay. As Dr. Ryan said, we have problems with collective dose, and you know that so I won't go into that anymore. But if you look at the methodology that you used in the results, actually I want the slide, the one you had. It was one up. Previous.

MS. SAMPSON: Oh, okay. Certainly.

MEMBER CLARKE: Again, apart from the -- as a chemist in a former life I don't like to see that many significant figures either, but it's not a unique problem. Those numbers look all pretty much the same. I mean, the regular and key were -- even though the key train had operational limitations compared to the regular it looks like the results were indistinguishable.

MS. SAMPSON: The operational limitation of 50 mile an hour speed restriction was indistinguishable by the time you transported it over several thousand miles.

MEMBER CLARKE: And even if you factor in reasonable uncertainties there doesn't appear to be much difference between the regular and key.

MS. SAMPSON: I think that's a valid conclusion.

MEMBER CLARKE: Is that a valid conclusion?

MS. SAMPSON: The study was of course conducted by VOLPE with FRA, and a decision was made early on that this was the method that would be used for comparison. At the conclusion of the study, as you can see, the comparison is that you have less than one. What FRA does believe is that there are operational considerations which do impact the safety of transportation. Clearly the technological enhancements that are available with the smaller consist. And it would not have to be a one cask car consist. You could have a number of cask cars in a dedicated train and still benefit by use of dedicated fleet of cars, and the communications backbone that would be available with the ECP braking, and additional onboard sensors for bearing defect and failures that really do enhance the safety of this. Clearly, limiting the number of cars in a derailment, and limiting the interaction of other hazardous materials during a derailment are significant operational enhancements, independent of the comparative radiation risk analysis that was done.

MEMBER CLARKE: That's really not risk, but you know, the comparison that you did. Okay, thank you.

MEMBER HINZE: While you have this up there if I may, my recollection is that Number 6 was Hanford as a source, and Number 1 was Humboldt, if I recall correctly.

MS. SAMPSON: Yes.

MEMBER HINZE: And there was quite a difference between the population density per line mile in 1 and 6, but the distances were relatively the same if I recall. And yet these numbers come up quite close. Does this mean that the population density along the line mile is really not a very significant factor?

MS. SAMPSON: I think I would defer maybe to Dr. Weiner, her familiarity with the Radtran program. And that's really a function of the Radtran program. She probably can speak to that better than I can. If that's?

MEMBER WEINER: That's fine. As long as you've point out, I'll make two points. The routing code that was used for this was INTERLINE, and it is really -- it's really more a function of the routing code than of Radtran itself. The INTERLINE uses existing railroad tracks and population densities within a half mile of the route. The existing railroad, the use of existing railroad tracks answers the question you asked awhile ago, which is tracks go from city center to city center. So if you try to avoid urban areas, you have a very, very long route. The second thing is that the longer the route, what almost any routing code will tell you is the longer the route, the more the results that you get look alike. And because you're integrating, you're spreading the population over a very long route, and on the average these become very close to the national average, rural, suburban and urban populations. And by the way, when you divide into rural and urban populations, the population divisions are also a function of the routing code itself. These were developed by Oak Ridge as part of the routing code, so that's why these things look alike.

I have to add my objection to four significant figures, and I already have transmitted this to the FRA people.

CHAIRMAN RYAN: Could you back up to the accident slide.

MS. SAMPSON: The one showing the numbers?

CHAIRMAN RYAN: Yes. Next slide I guess it is. In your accident cases, did you do a deterministic, you know, here's what happens, here's the dose, or did you do a sampling, or a probabilistic analysis, or how did you arrive at 70.90 person rem?

MS. SAMPSON: The FRA's rail accident database was utilized. And utilizing FRA's historical rail accident database from 1988 through 2001, actual accident numbers were utilized to determine probabilities. Those numbers were normalized --

CHAIRMAN RYAN: That's the accident happening part. I'm talking about the consequence. How is that assessed?

MS. SAMPSON: The consequences are based on the cask performance dependent upon the information that we gain. What type of accident we identify that it would be, and then the cask response to that accident type. And Earl would like to speak up about that.

CHAIRMAN RYAN: It's deterministic is my question.

MR. EASTON: I think these accident doses are really based on emergency --

CHAIRMAN RYAN: And tell us who you are please.

MR. EASTON: Back again. Earl Easton with the staff. I think these accident doses were really based on the emergency response, and how long it would take, and how complicated --

CHAIRMAN RYAN: I'm asking a real simple question, Earl. I don't want to go through the scenario. Is it deterministic or probabilistic?

MR. EASTON: I think it's deterministic.

CHAIRMAN RYAN: Okay, that's what I wanted to know. Because I think that's something where there's an opportunity to gain insight. If you're just assuming one set of accident parameters, that is the cask gets whacked, there's a fractional release, the fractional release exposes X people in a certain way, and we come up with 70.9 rem when we add that all up, that's one realization. What are the other realizations that you could come up with to gain insight?

MR. EASTON: This is based on loss-of-shielding accident as opposed to a release, I believe.

CHAIRMAN RYAN: Whichever. My point is it's a deterministic one-off set of assumptions, correct? That's what I need to know. Again, I think that's an area where if you wanted to look at an improvement, it would be to try and identify some critical group and then do a number of realizations, and a number of scenarios to see what impacts might be. It's a way to think about it in a little bit more of a probabilistic sense.

MS. SAMPSON: And again, the cask prototype here was a steel-lead-steel cask, which is important in the loss-of-shielding issue.

CHAIRMAN RYAN: Sure. Absolutely. Thank you.

MEMBER WEINER: Just to respond to that last, the raw analytical results from the analyses were not available in the final report, and they were not -- I haven't looked at them. However, if indeed Radtran was used to calculate the accident dose risks, this was done probabilistically and not deterministically.

CHAIRMAN RYAN: Well, this is deterministic --

MEMBER WEINER: Well, yes but he didn't --

CHAIRMAN RYAN: -- you don't know, but maybe --

MEMBER WEINER: That's correct.

MS. SAMPSON: The input into Radtran -- and let me back up. Maybe I can help with this a little bit. The accidents were based -- the historical FRA accident data was analyzed, and then was grouped into predefined accident categories to determine the probability that you would have an accident in one of those categories. And then those dose rates of the accident categories were the inputs that were put into Radtran, along with the anticipated delay time, to come up with the dose rate. So.

CHAIRMAN RYAN: It's this information that led me to conclude it's deterministic.

MS. SAMPSON: So the delay event was assumed to be an additional 10 hours on top of the regular transport time with the cask remaining at 10 mrem/hour for that entire duration. Radtran was used to evaluate all six of the transportation routes. The same was true for accident Category 2 and accident Category 3, and the delay time for regular and key train service was determined to be slightly longer than the delay time for dedicated train service, which is really what results in your increased dose rate for those evaluations.

MEMBER WEINER: Yes, which indicates that in fact Earl is correct because the probabilistic aspect of Radtran accident analysis was not used. These were --

MS. SAMPSON: This is the way --

MEMBER WEINER: That was --

MS. SAMPSON: I'm sorry if I was a little slow getting all that put together, but.

CHAIRMAN RYAN: No, I appreciate the fact that you're following up on where it preceded in your text, and we appreciate that.

MEMBER WEINER: I have a couple of questions. One is why was there any reason for using 6672 rather than the modal study, for example.

MS. SAMPSON: I don't believe the modal study was completed when they started doing this. I may be wrong about that.

MEMBER WEINER: Well --

MS. SAMPSON: It was completed during the time --

MEMBER WEINER: It may be a question you can't answer. How did your results compare with the Yucca Mountain EIS? Did you do any -- did FRA do any comparison?

MS. SAMPSON: We have not done any comparison to date, no.

MEMBER WEINER: Finally, is there an accident that in this suite of accidents, is there something that would correspond to the Baltimore Tunnel Fire?

MS. SAMPSON: Jump in. Feel free. Please.

MEMBER WEINER: Yes, Earl?

MR. EASTON: And the reason I'm jumping in is the original law said the FRA DOT in consultation with the NRC should do this study. So we did review the underlying technical stuff. What the VOLPE center conclusions were, that accidents involving fully engulfing fires at greater than the NRC cask certification's duration and intensity would be reduced by 89 percent. But the numbers again are very small. They'd be reduced from 1 in $4.2x10^{-15}$ to $4.6x10^{-16}$. It's an 89 percent reduction, but when you work out in terms of years, that's once in every 250 million years versus once in every billion years for this campaign. So the numbers are very, very small reduction in that type of event.

CHAIRMAN RYAN: And that's one side of the story. The probability of an event is one thing to consider. But the consequences is the second part, and I think it's risky to rely on saying, well the probabilities are very low, to then just hang your hat on a strictly single deterministic assessment of impact.

MR. EASTON: We do do a consequence analysis in 6672 for long duration fires where you get fuel breach cladding and all, and it shows that the release tends to be very low also. So if you linked the two together.

CHAIRMAN RYAN: And that's what I'm asking.

MEMBER WEINER: Any staff?

MR. SCOTT: Ruth, I've got one.

MEMBER WEINER: Mike.

MR. SCOTT: Mike Scott, ACNW staff. In one of my previous lives I had the good fortune of working for a nuclear utility that probably has shipped more spent fuel than any other, and we typically would ship it about 100 miles between one place and another, and if I recall correctly and my memory doesn't fail me we would ship two cars at a time. Your assumption was one car, correct?

MS. SAMPSON: The -- all of the assumptions for the study are based on a single cask car in the consist, yes.

MR. SCOTT: I'm wondering, especially on a cross-country route, it would seem that economics would strongly dictate several more than one at a time. Did that enter into the considerations at all, and what do you think the effects would be on your conclusions?

MS. SAMPSON: I believe, and I apologize. In -- let me -- I will answer your question, but let me -- there is a technical study that supports the report to Congress. The technical study was completed by the VOLPE center and has been submitted to the FRA. However, I do have to apologize. We hoped that it would be available by now. The technical study is still in review process with the FRA. It's not a contents review. Because the study has been worked on for so many years and has been transmitted electronically between Cambridge and Washington, and between various agencies here in Washington, there are several significant editorial problems with the technical study right now. Figure numbers don't match up correctly anymore with the actual figures that they're supposed to correspond to, data has been dropped out of tables, headings are missing. FRA is trying to utilize their resources that have worked with the study over the number of years to do that review of the document and try to get it into a format where it won't have a lot of technical problems with the technical study. And we do hope to have the study available in February of this year, and as soon as it is available we will place it on our website. It does provide a great deal more of the background information. It provides examples of the event trees, and in the actual analysis of each of the six routes that were reviewed. So it does provide better information.

One of the things that was looked at in the technical study, and I don't have it tapped, but there was some consideration given to a two-cask consist, and how that might impact some of the results. It's a much less detailed review, because it was kind of tacked on as we came to the end of the study. The utilization of two casks has some impact, but it's a very minor impact on the results. It really didn't significantly change the findings in any way. There is a little bit of an address of that, and I think your point is very significant. It does not make economic sense to take cask cars across the country one car at a time. It's not an efficient use of resources. Doesn't seem to be, from my opinion.

MR. THADANI: I don't really have a question, but a couple of comments probably. The first one, I think that if you do more realistic analysis, at least technically you might conclude that there's essentially no difference in the outcomes. And so one would be then forced to make what I would think would be a policy decision based on perhaps some engineering considerations that you talked about. And then that would make sense.

The second comment that concerns me is when we talk about probabilities that are so low, 10^{-10}, 10^{-15}, whatever it is, then I think one needs to think about the uncertainties. That's what's going to drive whatever decision you're going to make. Because quite honestly those numerical values are not very useful. I'm reminded that perhaps likelihood of a meteorite striking certain parts of the United States is probably higher than some of these estimates. So I just urge caution in the use of these probabilistic estimates. All it tells me is then I have to look for what else can get me in trouble, rather than this particular model I'm looking at. That's it, thank you.

MEMBER WEINER: Are there any questions or comments from members of the audience? Come up, then and identify yourself.

MR. MALSCH: Yes, I'm Marty Malsch. I'm a lawyer with the State of Nevada. I just had two questions. One is what did you assume by way of the rail corridor between the existing lines and Yucca Mountain?

MS. SAMPSON: I do not know what the INTERLINE utilized to get to Yucca Mountain since there is not a rail line to there. I don't know the answer to that.

MR. MALSCH: Okay. And then my second question was in doing the comparison you eliminated Category 4 accidents purely on the basis of probability rather than risk. Yet in other categories you're comparing risk across the transportation modes. Why is that?

MS. SAMPSON: Again, I apologize. That's a decision that was made at the outset of the study. There was analysis done of rail accidents that had happened utilizing FRA's rail database, and the accident that would result in forces that were equivalent to those identified in the 6672 were not identified in the existing rail database. So it was eliminated. But it was a decision made at the outset of the study.

MR. MALSCH: Okay, thank you.

MEMBER WEINER: Bob, would you?

MR. HALSTEAD: Oh there it is. It's a clamp. Okay, got it. Thank you. Bob Halstead, State of Nevada. I just want to make a comment that we do endorse the conclusion of the report favorable to dedicated trains. I would add to Marty's comment, we were involved in that 1992 workshop. Most of the stakeholders wanted to see the Category 4 rolled in.

I don't want to repeat, although I agree with much of the discussion about the probabilistic analysis, but there's a point here where quantitative analysis doesn't always give you a good handle on whether as a matter of policy giving added assurance that you eliminate the potential for accidents like the Baltimore Tunnel Fire involving spent fuel, there just isn't any really good way to quantify that even though Earl as always has a number to throw on the table for it. I think there are some security advantages that are also very hard to put any kind of a cost-benefit number on.

The State of Nevada has a petition for rulemaking, PRM73-10 that has been before the NRC for now going on seven years arguing that use of dedicated trains would be a good idea for security reasons. Congress ordered the GAO to do an assessment of that in 2003. They concluded that that was a good idea. I realize back when you were directed to do this study that wasn't one of the concerns, but since then security issues are involved.

And while Nevada has consistently advocated use of dedicated trains, I do want to say we're sensitive to this issue of the train crew dose, and while again I agree with the discussion here that it's probably pretty low and not a good discriminator between different classes of service, nonetheless it probably would be a good idea, given the concerns on the part of the railroad unions that with the exclusive use dose rate assumed, which would be a higher routine dose rate, it probably would be a good idea to recalculate the train crew doses not to come up with an LCF calculation, but to come up with some number on -- given the expected crew rotations, what are the maximum annual doses to a particular crew, or a particular worker. And I think that goes in line with Dr. Ryan's concern that those collective dose numbers not be misused. Thank you.

MS. SAMPSON: I do want to say, the FRA is very aware of concerns raised by the rail unions, the Brotherhood of Locomotive Engineers and Trainmen, and also the United Transportation Union. And we have met with them on several occasions. FRA is currently undertaking a process to try to identify some baseline dose rate information for our rail inspector employees, and we hope to be able to utilize some of that information to assist the railroads in developing their own radiation dosimetry programs if they determine that that would be beneficial to them. It is a concern of the rail workers, and something that does need to be addressed with them for all modes of, you know, for all routine patrols transportation.

MEMBER WEINER: Any further questions? Hearing none I'll turn it back to the chairman.

CHAIRMAN RYAN: Thank you, Ruth, and thank you very much again for your presentation and our other fine presentation this morning. Let's see. We are adjourned for lunch until 1 o'clock, and I think after lunch we have just a brief preparation for the Commission briefing. The Commission briefing and then letter-writing. So I believe this will close our formal record for the day. So we'll close the record here, but we will come back to prepare for our Commission briefing at 1 o'clock. Our Commission briefing is scheduled from 2:00 to 4:00 p.m. We'll be in again White Flint 1, the large public meeting room over in the other building. And then we'll reconvene here after the conclusion of the briefing to follow up on this discussion of letters, on what we're going to write. And then I think we're scheduled for first thing Thursday morning to take up the details of the Part 63 letter, and anything else that we decide late in the afternoon. And Ruth's transportation, we'll take that up this afternoon, or afterward. Thursday morning?

MEMBER WEINER: Thursday morning because I want to get it printed.

CHAIRMAN RYAN: All right, Thursday morning it is. All right, very good. Thank you all and see you at 1 o'clock.

(Whereupon, the foregoing matter went off the record at 11:39 a.m.)