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UNITED STATES NUCLEAR REGULATORY COMMISSION'S

ADVISORY COMMITTEE ON NUCLEAR WASTE

July 20, 2005

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UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

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ADVISORY COMMITTEE ON NUCLEAR WASTE (ACNW)

161ST MEETING

+ + + + +

WEDNESDAY,

JULY 20, 2005

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ROCKVILLE, MARYLAND

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The Advisory Committee met at 9:30 a.m. in Room T-2B3 of the Nuclear Regulatory Commission, Two White Flint North, 11545 Rockville Pike, Rockville, Maryland, Dr. Michael T. Ryan, Chairman, presiding.

MEMBERS PRESENT:

MICHAEL T. RYAN, Chairman

ALLEN G. CROFF, Vice Chairman

JAMES H. CLARKE, Member

WILLIAM J. HINZE, Member

RUTH F. WEINER, Member

ACNW STAFF PRESENT:

NEIL M. COLEMAN, Designated Federal Official

THERON BROWN

LATIF HAMDAN

MICHELE KELTON

MICHAEL LEE

RICHARD K. MAJOR

SHARON A. STEELE

ASHOK THADANI

ALSO PRESENT:

KIRSI ALM-LYTZ, NRR/IPSB

RAMIN ASSA, RES

TERRY BROCK, NRC/STP

STEPHANIE BUSH-GODDARD, RES/DSARE/RPERWMB

RALPH CADY, RES/DSARE/RPERWMB

DAVID M. DIODATO, USNWTRB

ALLEN FETTER, NMSS/HLWRS

BOB FINCH, DOE/RW

B. JOHN GARRICK, Invited Expert

CHRIS GROSSMAN, NMSS/HLWRS

NORM HENDERSON, Bechtel SAIC Company

VINCE HOLAHAN, RES/DSARE

PHILIP JUSTUS, NMS/HLWRS

JON KIRKWOOD, BAHOCRUM

ALSO PRESENT: (CONT.)

PETE LYONS, OCM

TIN MO, RES

COLEMAN NEALE, Chambersburg Avocado

EDWARD O'DONNELL, RES

BILL OTT/RES/DSARE/RPERWMB

JAKE PHILIP, RES/DSARE/RPERWMB

JOSIE PICCONE, OCM/PBL

PHIL REED, RES/DSARE

JAMES RUBENSTONE, NMSS/HLWRS

JOHN RUSSELL, CNWRA

ADAM SCHWARTZMAN, RES/DSARE/RPERWMB

JOHN STAMATAKOS, CNWRA

NICHOLSON V. THOMAS, Williamsport Hydro

CHERYL TROTTIER, RES/DSARE/RPERWMB

AGENDA

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

(9:34:18 a.m.)

CHAIRMAN RYAN: All right. It is the appointed hour of 9:30. The meeting will come to order. This is the second day of the 161st Meeting of the Advisory Committee on Nuclear Waste. My name is Michael Ryan, Chairman of the ACNW. The other members of the committee present are Allen Croff, Vice Chair; Ruth Weiner, James Clarke, and William Hinze.

During today's meeting, the committee will hear briefings by and hold discussions with representatives of the Office of Nuclear Material Safety and Safeguards on the IAEA's Requirements Document on Geological Disposal of Radioactive Waste. You will hear a briefing by representatives of the Office of Nuclear Regulatory Research regarding generic waste-related research programs, and we will hold discussion with representatives of the RES Staff regarding development of a White Paper for the use of Collective Dose in making regulatory decisions.

We will continue preparation and review of ACNW letters and reports. Neil Coleman is the Designated Federal Official for today's session. Neil is here. Sharon will be the Designated Federal Official until Neil's return, Sharon Steele.

We have received no written comments or request for time to make oral statements from members of the public regarding today's session. Should anyone wish to address the committee, please make your wishes known to one of the committee staff. It is requested that the speakers use one of the microphones, identify themselves, and speak with sufficient clarity and volume so that they can be readily heard. It is also requested that if you have cell phones and pagers, kindly turn them off or place them on mute. Thank you very much.

Before I get into the formal part of today's agenda, I'd like to ask Cheryl Trottier to step up. And I want to read a letter into the record. And this is in recognition of Cheryl's retirement from the NRC.

"Dear Cheryl: Please accept this letter of congratulations and good wishes from the current members of the Advisory Committee on Nuclear Waste on the occasion of your retirement after many years of federal service. Your service to the commission, especially in the Office of Nuclear Regulatory Research has been exemplary and appreciated. The current ACNW members have worked with you for just a short time, and during this short time we have all

come to appreciate your knowledge and contributions. Your collaborative style, your gracious personality have made your presentations and the related work of the committee both productive and pleasurable for us all.

The ACNW wishes you all the happiness that you have earned and so richly deserve in your retirement from full-time employment. We have heard from many past members of the committee, and they extend their good wishes to you, as well. Sincerely."

DR. GARRICK: On behalf of the former members we say amen.

MS. TROTTIER: I won't make a speech, but I will say thank you. This was a surprise, and very, very much appreciated. I do want to say one thing. The ACNW has been a big help to the Office of Research, both in helping us to define our research goals and our program, and in giving us a lot of really valuable feedback, so I really want to thank you personally, and for the office.

CHAIRMAN RYAN: Thank you. And welcome, again, once past Chairman, Dr. Garrick. Dr. Garrick is with us for the morning session.

We're scheduled now to have a staff briefing on International Atomic Energy Agency

Requirements Document DS-154 regarding the design and operation of facilities for geological disposal of radioactive waste.

MR. FLACK: Mr. McCartin is missing in action.

CHAIRMAN RYAN: Soon to be arriving?

MR. FLACK: Hope so. We've sent out a runner. I just came back from the seventh floor. No one knows where he is.

CHAIRMAN RYAN: Perhaps he's on his way, so we'll just maybe put a pause in the record and let him arrive in the next few minutes, hopefully. He is scheduled at 9:45.

MR. FLACK: And his aware of his commitments.

CHAIRMAN RYAN: Six minutes, so I finished a bit early.

(Whereupon, the proceedings in the above-entitled matter went off the record at 9:38:29 a.m. and went back on the record at 9:44:48 a.m.)

CHAIRMAN RYAN: I guess we can go ahead and get the record started again, please. For everybody's benefit, this is an information briefing, and I think we've requested that Tim share with us information that he learned at a meeting in Vienna at

the IAEA, was it?

MR. McCARTIN: Yes. Well, it's a series of meetings.

CHAIRMAN RYAN: A series of meetings, and it's intended really to help us take advantage of the fact that Tim is very involved in the issues related to the IAEA documents and geological disposal issues that I think will be of interest to the committee, so this is one of those happy times when there won't be a letter due. We're hoping to hear what's current and what the newest thinking is. This is probably best expressed as our effort to be in the right context when the EPA issues their draft standard, and hopefully we'll be hearing things that might be related to that, or other things you've learned. With that, I'll turn it over to you. Thanks for coming.

MR. McCARTIN: Sure. Thanks. And I apologize. It was my oversight about making copies for the meeting. And I know Mike's out there churning away, and they'll be here shortly.

In general, for about the last four years or so, the NRC has been assisting the IAEA in development of an International Standard for Geological Disposal. In terms of where they are, they're very close to finalizing the standard, and

it's expected that the Board of Governors at the IAEA will approve and finalize that somewhere in the September time frame, and so it's close to being final. And what I'll do is go through the background, just very brief background information in terms of the IAEA, and then really get into the safety fundamentals that support geological disposal. And then get into some of the specifics in terms of the requirements for geological disposal that are in the standard.

With that, the IAEA has a radioactive waste safety program, and in those standards they specify principles and requirements for safety of waste programs in general. There's guidelines for implementation, and the primary purpose for doing this is that there's these internationally agreed upon safety standards provide a reference point for national criteria standards and practices, that they expect that many countries that are developing programs, they can adopt the IAEA standards if they so desire or use them in a way in developing their radioactive waste safety programs.

In terms of the documents that IAEA -- just to put where the discussion -- it's termed DS-154 Draft Standard, 154 is the standard for geological disposal. There really are three primary categories

of safety-related documents that the IAEA publishes, and one is *Safety Fundamentals*. And these provide objectives, and concepts, and principles for a broader class. In this context for all waste disposal activities. The fundamentals would apply to low-level waste, as well as to high-level waste. And they're really overarching principles.

Below that are safety requirements, and that's really the safety standard I'll be talking about today as a Safety Requirements Document. These are the requirements that need to be met to ensure safety. And then below that are safety guides, and these tend to be actions of conditions that are procedures that you do in meeting the safety requirements. And not too dissimilar, you can see almost a pattern at NRC. We have regulations and then we have guidance documents, and so there's a kind of a parallel between those two.

With respect to the safety fundamentals, there are principles that the IAEA has put forward that apply to all radioactive waste management activities. Some of these objectives of waste management I've listed here. And as I said, they're very overarching concepts that protect human health and the environment now and in the future, not impose

undue burdens on future generations, so you see they're very broad principles, and they apply to really all radioactive waste management activities.

With respect to geological disposal, now I'm getting to what's in DS-154. They have objectives for meeting the protection of human health and the environment, and these include quantitative criteria. I'll give you an idea of some of the quantitative criteria that are being proposed in the IAEA document.

There's a strategy for achieving the safety. And certainly, with respect to geological disposal, they're talking about all phases of a repository program, the development, the operation, and closure of a geological repository.

In terms of the safety objectives for operations, they have a limit on radiation doses to workers and the public. For the worker it's 5 rem in one year, and 2 rem per year averaged over five years. And then for the public, the average dose in the relevant critical groups is 100 millirem per year, with the caveat there is an ALARA principle, as low as reasonably achievable that is evoked for operations.

For post closure, the limits on radiation dose to the rest of the public are -- there's a recognition that 100 millirem is an appropriate level

per year from all sources, and 30 millirem per year would be apportioned to a disposal facility, such as a geological disposal, and they recognize that's a risk constraint on the order of 10 to the minus 5 per year. And the standard makes -- you can use either a dose or a risk limit on that order.

They do express there's a caution on applying the criteria at long time periods in the future. There is no specific cut-off in terms of carry the calculations out, but there is a recognition that as you go out further in time, you have to consider where uncertainties may make the information, may not provide reasonable information to decision-makers. And the large question is what's long. And in the document they suggest that the long term is on the order of thousands of years, but there's no precise number given, but long term is given an example of on the order of thousands of years.

CHAIRMAN RYAN: Tim, just a quick question on the one above.

MR. McCARTIN: Yes.

CHAIRMAN RYAN: The risk constraint is recognized to be on the order of 10 to the minus 5^{th}. That kind of implies to me that that risk level is kind of what's being recommended as okay. There's

really probably not a lot of difference between 30 and 100 millirem per year, so this idea of all sources and an individual source kind of gets muddied up a bit, in my view. Does that make sense to you, or am I off base?

MR. McCARTIN: Well, you're right, on the order of -- the 30 millirem is on the order of that 10 to the minus 5, and yes, you could say --

CHAIRMAN RYAN: And it's on the order of 100 millirem.

MR. McCARTIN: Once you use the words "on the order of", yes, I would agree. But they still -- the standards try to provide - and remember, this will be used in a variety of countries, and they tend to provide a framework without really -- there is some flexibility.

CHAIRMAN RYAN: I guess that's the key, isn't it? The individual country would have to answer the question I'm raising and interpret it for themselves.

MR. McCARTIN: Yes.

CHAIRMAN RYAN: Okay.

DR. LARKINS: Yes. I was interested in the same thing, what do you mean by "on the order of"? Is that a factor of 10?

MR. McCARTIN: I think they would way no, not a factor of 10. There is a desire that to provide flexibility to member states to do a reasonable approach consistent with the standards.

I will say one of the fascinating things, and probably the most fascinating aspect of going over to IAEA, in my mind, and working with the people there on a geological disposal standard is, the difficulty in picking the right words. It's one thing if you're in a country where okay, English, is the language to be used. They tried to adopt words that when translated into other countries' languages, will have a similar meaning. And you quickly run into things that are very -- it's very challenging for them, because sometimes there'll be a particular statement that maybe someone from Yugoslavia will say well, we won't be able to translate. I'll tell you how it's going to translate in our language, and it's not the same meaning. And there's always this attention of what's the -- it may work well in English, but in a different language, it doesn't. And that actually -- sometimes look at the difficulties we have picking the right words for our regulations, but at least we only have to confront the issue of one particular language being used.

CHAIRMAN RYAN: We struggle with the ICRP documents in the same way, and that's English.

MR. McCARTIN: Yes.

CHAIRMAN RYAN: I think it's a good point to spend another second or two on.

MR. McCARTIN: Yes.

CHAIRMAN RYAN: Have I died and gone to heaven? What's going on?

DR. GARRICK: You don't need to worry about that.

CHAIRMAN RYAN: These documents really are guidance in that way, that they are designed for a broad use in countries. And I think sometimes we want to be very analytical and interpret 30 versus 100 and what it means. I think the caution you're describing is a very good one to keep in mind for IAEA documents of this type, that they're really general in nature, and not specific. So I think that's a really good bit of information and insight.

MR. McCARTIN: And these are the standards where they are more general. In the guidance, they sometimes will get more specific. Here's something you can do, and that's the approach they have taken.

MEMBER HINZE: Before you leave that if you would, Tim; what's the origin of that caution on

applying the criteria? What's their justification for that statement?

MR. McCARTIN: That quite simply, I think the debate we've seen in this country, that carrying calculations out to the indefinite future can be problematic. And it's just a recognition that as you go out further and further in time, there's uncertainties, and issues that - what does it mean? What does that result mean? And certainly during the development of this standard, there was recognition that as, in your letter, you know different countries have different time periods. There is a spectrum of time periods, and how far out you go should be an issue that needs to be addressed by the particular country. It could be site-specific. As in long-term, why thousands of years, a recognition that there was a significant inventory early-on that decayed over the first few thousands of years. And it's important to have a quantitative calculation and comparison in that early time period when you have a very significant inventory, is why, as I understand it, why thousands of years were suggested as a long time period. How far beyond that you go is -- they felt that there needed to be flexibility for the different countries in implementing the standard.

MEMBER HINZE: Do they see a development of the safety guidelines regarding that issue? We've talked about the standards here, but providing guidelines for this.

MR. McCARTIN: Right. And we are working on the guidance document. We are assisting them in the guidance documents, also, and there is a guidance document being worked on currently. Right now I think in general you'll see a similar theme, but I don't believe there will be any quantitative statement, other than the more general one, that as you go out in time, each country is going to have to decide where the calculations get to a point where maybe you want to go to a more qualitative look, or consider other performance measures. And the IAEA, in this context, recognizes how difficult it would be to set something out there, if they said a strict time, and quantitative up to this precise time.

It just would be hard not knowing the inventories, the characteristics of the waste, the site conditions, et cetera, that the countries have to grapple with that on their own. There really is not an easy way out of that one.

MEMBER HINZE: But I think what I'm getting from you is that the concerns here about

developing the guidance are based upon solid scientific technical information regarding the individual nations, and not necessarily just the policy of the nation. In other words, it's on the inventory, it's on the site, and it's on technical issues.

MR. McCARTIN: Yes. And as importantly, the limitations of science as you go out to longer time periods, a recognition that when you get to hundreds of thousands of years, possibly a million years, you may choose to do things differently for those same scientific reasons.

MEMBER HINZE: Right. Thank you.

MR. McCARTIN: In terms of a strategy for development of geological disposal, there's really three primary tiers. And one is, there's a requirements for the legal and organizational framework, that there needs to be specified very clearly the responsibilities of the government, the regulator, the operator. In some respects, one of the things with the government, where is the funding for a geological repository coming from, so there's certain requirements for the government to ensure funding is there.

Regulator has certain requirements, such

as specifying what criteria need to be applied to the repository, et cetera. The operator demonstrates -- but that needs to be delineated clearly. In terms of a safety approach, there is certainly the development process that once again, recognition that development of a repository would take place over potentially many years, decades, and so the development should be done in a step-by-step fashion. Also, passive safety that is focused, and I should say the document does talk to all phases, the operational, as well as post closure. The emphasis is more on the post closure, but all phases are talked to. And so passive safety for post closure is fundamental. How you develop an adequate understanding and confidence that the safety measures have been met. And then, of course, safety design principles for the post closure, multiple safety functions, multiple barriers very similar to the U.S. requirements.

They speak of containment and isolation. And here again, what is the distinction between containment and isolation? Containment is really achieved by containing the radionuclides in the waste packages in the repository itself. And once again, there is some discussion about you expect early-on a substantial containment, if not near 100 percent.

There might be some small releases, but in that first thousands of years, that the container, the waste package would remain in tact. But eventually, the containment with the waste package would go away, and then you have isolation. And it's the geological system that provides for the isolation from the biosphere, but there's also a recognition that this isolation, even with releases from the repository, that in general the reason you're going to a geological repository, you're going deep underground, the geology itself isolates the waste from humans. And so they talk of the two concepts of containment and isolation.

In terms of the framework for geological disposal, as I said, there's a recognition of the step-by-step development that indeed information will continue to come in through the various stages of repository development. And there needs to be an approach for doing that, and that gets to the preparation of the safety case and safety assessments that you expect that this iterative feedback loop, as you learn more information, you provide it to the safety assessment and improve your understanding and confidence.

Now I will say there has been a discussion

of safety case versus safety assessment. In our regulation, we have elected not to try to make a distinction between the two. But in this particular document, the safety assessment is the performance assessment itself. The safety case includes that safety assessment, as well as all the supporting information that supports the safety assessment. Generally, as you know, in our regulation we have not pointed out something, a safety case versus a safety assessment. Our performance includes that calculation, as well as all the supporting information that gives you confidence that, indeed, the calculation I performed is technically defensible and reasonable. But in this case, it is more typical in the European environment to draw this distinction, but you don't see it in our regulation. But I would say there isn't a difference here. It's just we have combined it into its all, part of what we would call the safety case or safety assessment.

DR. LARKINS: Do they distinguish between who makes the safety case and the safety assessment? Is the safety case the collection of data and information that would be used to support the assessment?

MR. McCARTIN: In both cases, the safety

case and safety assessment is made by the developer, and would be reviewed by the regulator. So it's an interesting distinction. We prefer not to separate all the information and scientific knowledge you have supporting your safety assessment from it as a separate -- it's one collection.

MR. THADANI: But safety case would include any public hearings and so on, wouldn't it?

MR. McCARTIN: That's a -- yes. I mean, that's part of the overall information base, absolutely. And in that sense, maybe you've brought up possibly a good distinction of why the word "safety case" exists. Yes. I mean, it's intended to, as this body of information grows with time, you continue to document it. It's in place and passed on. Yes.

They talk of the scope of the safety case and the safety assessments. And you're right, although I'd have to go back and look. I don't know if they specifically bring out information from hearings, but there is certainly the concept of there's information that supports the safety assessment, which clearly would be information from hearings that is continued through and improved on through this iterative process. And certainly, they talk about the documentation of the safety case and

safety assessments in a way that they believe it's important that the documentation of this be available for outside review. And there's discussion that there could be documentation that might be more appropriate to be reviewed by others that aren't as necessarily as quantitatively and technically involved as the regulator. There's documentation supporting the regulatory review by scientists. There could be other documentation that provides a more general approach, and that would be more by the developer.

In terms of this development, as I indicated, there are different steps along the way, and they talk to site characterization, design, construction, operation, and closure. And so along the way, you'll see a progression of development of the safety assessment, safety case. And importantly, up front they say even at a crude level, a safety assessment should be done very first step. I mean, obviously you have to get some information from site characterization, but even with your information at a very limited level, you start to develop well, what is my safety case? What am I relying on? And as you go through design, as things evolve, and you continue to iterate through identifying what's important to safety, what I'm relying on, and that continues all

the way through closure, this constant iteration. But there's an emphasis that the safety case should be foremost in the minds of the developer from the very first stage.

MEMBER HINZE: Tim, is there any sharing of safety assessment software procedures as part of t his? Does each country develop its own?

MR. McCARTIN: Well, in terms of development of the standards, there is no performance assessment software, et cetera involved, other than, obviously, the different people that come to assist the IAEA have some performance assessment tools, for lack of a better word, and their access.

Now along those lines, though, countries developing a program, say a geological repository program, can ask the IAEA for assistance, and they have different mechanisms for providing software, et cetera.

MEMBER HINZE: Do we, for example, share our performance assessment software in any parts or parcels with others?

MR. McCARTIN: Other people have used our software. How exactly, I will say -- how we share it varies depending on -- I know over the years, and I'm thinking back to the last 10 years or last 20 years,

depending on the U.S. Government's approach for software, it does have different nuances in terms of who we will share our software with for free, and who will sell it to. I mean, it does vary.

MEMBER HINZE: Well, what I'm getting at is, do we learn anything from other software and procedures in terms of safety assessments?

MR. McCARTIN: Not through this particular effort.

MEMBER HINZE: Setting the standard.

MR. McCARTIN: Yes. We certainly, technically, are you aware of developments in other performance assessment arenas in different countries and what they're doing. One of the problems, I'll say, is that the -- you quickly through these different steps, you quickly get to a very particular application. And I'd say our performance assessment, as well as DOE's and EPRI's, is very much tailored to Yucca Mountain.

MEMBER HINZE: Very specialized.

MR. McCARTIN: Yes. However, there are pieces that are somewhat common to -- I'll say one of the ones, the Latin Hypercube Sampling, as an example, that piece of software is used by different countries, as well as DOE, ourselves, and that sampling procedure

is amenable to just about any probabalistic analysis, and so it's used. But I'll say, as our development has progressed, it's gotten very specific to Yucca Mountain.

MR. THADANI: Following up on Bill's question, do you do international standard problems for some way to check the analytical tools that you're utilizing?

MR. McCARTIN: Yes. Actually, when I was in the Office of Research, I think about 10 years ago now, there was a series of international benchmarking studies that the Swedish Nuclear Power Inspectorate somewhat oversaw in terms of trying to benchmark transport codes, other ones with respect to Rock Mechanics, and there have been international efforts to try to get gee, do we think these codes are generally applicable and getting reasonable answers. And so yes, that was a very important step.

MEMBER HINZE: The Swedes would be ahead of us in terms of Rock Mechanics, for example. That's what I'm getting at.

MR. McCARTIN: Oh, yes.

MEMBER HINZE: How much are we picking up from all of this, from this interaction?

MR. McCARTIN: Well, we've been involved

in both when the Swedish programs for Intraval, Hydrocoin, Intracoin. There was a series of ones primarily for the geosphere flow and transport models. The Rock Mechanics one, and I draw a blank of what the acronym for that, but we were involved in that one, also, and so we have been involved.

Now in addition to that, I'll say for both ourselves and DOE, we convened a group of -- completely separate on our own for our performance assessment model, we invited some experts from other countries to look at what we were doing and provide a peer review. And I think maybe a couple of years ago, or three years ago we reported to the committee on some of the peer review activities for our code. I know DOE asked IAEA to peer review their performance assessment, and I'll say on the order of three years ago, if I had to take a guess -- there's a documentation of that that I can provide you, so there's that aspect that is making use of other experts that are working on similar problems to look at this particular problem.

DR. GARRICK: Tim, if you think in terms of repository risk, you have to, of course, think in terms of pre-closure and closure. And I know you're talking about standards for closure, but we're seeing

a growing issue on Yucca Mountain with respect to the thermomanagement. And the thermomanagement is driven by a couple of things; one is to meet certain heat load requirements in the repository, but there's another issue, and the issue is that if you have to compromise the worker risk considerably to meet that, the question is, is it worth it, and what are the standards people doing to provide some mechanism where a rational optimization of the tradeoff between pre-closure and post closure risk; because there are many people that believe that the real risk of a repository is pre-closure. And I might be even one of those, and we're fiddling around here worrying about a few millirem a million years from now, when the possibility exists that we're going to exceed those levels considerably in a short period of time before the repository is closed.

Is there any fundamental regulatory thinking going on besides the existing standards and requirements to enhance our ability to better optimize the total risk of the repository?

MR. McCARTIN: Yes. This document, as I said, does address both the operational risk, as well as the closure, but the emphasis is more on the post closure safety. There is no discussion that I can

think of with respect to trying to manage the risk in a way -- worker risk with respect to post closure risk. However, I will say, and you may not like this, but there is discussion in the report that for things with respect to construction, with respect to monitoring, with respect to safeguards, that these kinds of functions should be done so as not to compromise post closure safety. And that's about the only -- so you wouldn't want to do something say in a safeguards manner that now compromises post closure safety, so there is a look from what we might be doing today, but the emphasis is more on you don't want to do it in a way that you're compromising the long-term safety of the repository. But that is more related to - and I'll say an easy example is monitoring; that would you want to put in a bunch of bore holes all over the place, that oh, we'll be able to see exactly what's going on.

Well, yes, you have, but now you're created pathways for radionuclides to possibly get out, and so the fact that you are putting it in in an in-tact geological unit, you wouldn't want to, for lack of a better word, swiss cheese the geological unit to monitor it. And now you've defeated the isolation aspect of that unit, so it's more with

respect to that aspect of not compromising a design aspect. But it's an interesting point.

I'm not aware of any discussion that was trying to look at a spectrum of worker dose in relationship to what might --

DR. GARRICK: The confusion that comes is that if you spend your time talking about closure, post closure, you leave the public and everybody to thinking that that's the total threat of a repository. And you may be ignoring the most significant threat in doing that. And if you look at the different scenarios that are now being bandied about with respect to thermomanagement, some of them are frightening in terms of the number of times that the fuel has to be handled, and the operations that accompany those scenarios. And it seems that there's not any vision being provided by either the regulators or the international community on how to deal with that problem. I was just curious to what level --

MR. McCARTIN: The closest I will say when Part 63 was out for public comment, I know we got some comment with respect to safeguards, and in the traditional sense, safeguards -- there's safeguards requirements for visually making sure something is there. And they said there may be some need for a

repository at some point. You would not want someone to physically go into a drift to make sure a waste container is there. And as I understand it, and I'd have to go back and look, but we talked of that, that certainly in the safeguards requirements, there is a flexibility that you would not compromise -- get very large doses. That there would be other ways that possibly you could ensure that the waste has not left, has not been diverted from Yucca Mountain without physical inspection. And there was a recognition there that there are certain safeguards requirements that you certainly would take into account what that requirement means, and the fact that to get a many ton waste package out of the tunnel, you might be able to just have a certain requirement for guarding that tunnel, so that gee, nothing did leave here, rather than physical inspection down a drift or something like that. But that's the only area I'm aware of that we certainly have looked at. But in terms of the fuel handling, it's an interesting point.

Going along with -- I mean, I've sort of talked to some of these points in terms of, once again, for assurance of safety and security, there's things that would be done. Early-on there might be certain waste acceptance criteria that might be

developed by the developer. Monitoring requirements, as I talked about, post closure institutional controls - there's a recognition that the repository would be continued to be monitored. But as I said, an important aspect there, whatever monitoring you're doing, you don't want to compromise the long-term safety.

In addition, there's the safeguards requirements that would require continued monitoring. And certainly, quality assurance is applied to all the important phases of development of a geological facility. And that's the way that, in addition to all the other things, that you get some assurance of safety.

In summary, these requirements - I talked to all those, and I realize probably the more general way, it gets to both the planning, designing, operating and closure of a facility. The strategy is important to ensure that each step in the development has an adequate understanding and confidence of safety. And that's an important aspect, that there is that recognition that as you move forward in a geological repository, information will improve as you get to closure. And with that, I'll be happy to answer any questions.

MEMBER HINZE: Is retrievability in there at all?

MR. McCARTIN: It's been a while since I've looked at the document.

MEMBER HINZE: I'm sorry.

MR. McCARTIN: Yes, in the context of the step-by-step approach. While you're developing it, you would want to be able to potentially retrieve the waste if you got to some step where you said gee, we now know it's not safe. And so there is some limited discussion, as I understand it, about retrieval, somewhat consistent with the U.S. regulations, but there's not any particular time frame given. But it's retrieval during the development of the repository.

MEMBER HINZE: It would seem to me that that would be -- retrievability would go hand-and-hand with monitoring. If you're going to monitor, you're either going to do a fix on it, or get rid of it.

MR. McCARTIN: Sure.

CHAIRMAN RYAN: And that fix may not be retrieving.

MEMBER HINZE: That's right. You may do a fix --

CHAIRMAN RYAN: Or retrievability might be an option, but not necessarily --

MEMBER HINZE: That's right.

CHAIRMAN RYAN: Any other questions, Bill?

MEMBER HINZE: No, sir. Thank you.

VICE CHAIRMAN CROFF: Early in the presentation, you had the objectives - protect human health and the environment. Where is the IAEA coming from on the environment part of that? We've had a lot of discussion in the ICRP context. Are they sort of following the ICRP trend or some other --

MR. McCARTIN: Right. Right now there's just a paragraph in the document that points to the fact that people are discussing possibility of limits for other things other than dose to humans. And it's under discussion, but there's no recommendation. It's just a recognition that there is discussion. I'd have to go back that specific enough -- I know at one time there was a statement that right now it would appear that protecting humans is appropriate for protecting the environment. Those dose levels are small, but I will say I can't guarantee that that sentence is still there, but there's no separate limit discussed, and they just acknowledge that it's being discussed in the international community, and they're following it, also.

VICE CHAIRMAN CROFF: Okay. Thanks.

CHAIRMAN RYAN: And, of course, we'd written on that subject the last time, and recognized the ICRP also affirmed again that if you protect man, you protect the environment. That's why the discussion going forward is recognizing the ICRP, as well.

MEMBER WEINER: I have a couple, Tim. Early in the Yucca Mountain considerations, I mean, like 20 years ago, EPA made the decision that the world in 10,000 years and society was going to be pretty much the way it is now. In other words, throwing out the idea that we were all going to lose all civilization and return to caveperson status.

Has the IAEA -- what does the IAEA assume about society over the very long term, or have they even discussed that?

MR. McCARTIN: In this document, they don't discuss that. They recognize that, like I said, the long-term is on the order of thousands of years, and I would have to go -- boy, it's been a while since I've read the document, and whether there's discussion about using reference groups, or reference biospheres, there could be. That might be something that's - and I have to be careful. I might be switching between guidance documents and standards,

because I've been assisting on both, and so I can get back to you on that. But other than there may be something, it's useful in performance assessments to specify some reference biospheres and critical groups.

MEMBER WEINER: Well, is there any further discussion of how you define say a critical group?

MR. McCARTIN: No.

MEMBER WEINER: My other question is very general. You said early in your presentation that there should not be undue burdens on future generations. What's an undue burden?

MR. McCARTIN: Well, once again, those are general principles that I think there's no definition, precise definition for what an undue burden is. But that gets to the concept of if doses are limited to things we find acceptable today, that it would not be -- that's sort of how in the standards you're getting to if you look at doses that are acceptable today, then that would not be an undue burden.

MEMBER WEINER: Thank you.

CHAIRMAN RYAN: Jim.

MEMBER CLARKE: Tim, early on you mentioned that there's guidance being developed, as well. Can you tell us a little more about that? How is that being approached? The areas that will be

addressed, and does it track the different topics, the way you showed us the requirements coming out?

MR. McCARTIN: Oh, it would track with the requirements. It would be a guidance document. The guidance document will be with respect to the standards, the draft safety standards.

MEMBER CLARKE: Okay.

MR. McCARTIN: And so it would track reasonably well with that. It's fairly early in the development, and right now what it does -- and see here's where something like say with respect to the reference biosphere and things of that nature, it might give some additional guidance to use a reference biosphere. And this is where I think there's some acknowledgment of it, but it gives a little more idea of the kinds of things you might consider. It might talk about some of the uncertainties, and how you might look at some of the uncertainties with the calculation, et cetera. And so it gets into a little more detail, but it would be related very much to the requirements.

There are some other things that I will say, a couple of the big topics, that are being thought about now for the guidance document. It's alluded to in the standards, this tie-in between how

safety assessment sort of is the glue that holds everything together, and the question -- the guidance document is trying to explain in a more direct way not only how safety assessments should be used to guide site characterization, to design, to integrate the design in the site characterization, and how it might progress, and what kinds of things you might be looking to do at the different steps, be it during construction - here are the things you would be doing. And so it's trying to give a more -- to me, if there's one aspect of the guidance document, it's trying to show how safety assessment is intertwined in all these activities, and it fits together, more so than the standard document, and steps that could be done, or should be done.

VICE CHAIRMAN CROFF: Okay. Thanks. Is there a schedule for the guidance development?

MR. McCARTIN: That's a little more difficult to get to, given we're helping out. I would say a year to two years. It might end up faster, but I'd say a year to two is probably not an unreasonable estimate.

VICE CHAIRMAN CROFF: Thank you.

CHAIRMAN RYAN: Tim, it seems like - just to follow on on Jim's question before we go to Bill or

John's, that they're about a half a yard short of risk-informed, because if they're using the safety assessment as the glue to kind of pull all the parts and pieces together from design, construction, on through to performance at the end, they're treating it as a system. And the central point of that system is the information they derive in their safety assessment. And the half-yard, of course, is then to go to risk-informed, and use other information besides the analytical assessment to make a judgment or a decision. Is that a fair summary? Am I hitting it right, or am I over-interpreting what you said?

MR. McCARTIN: Well, I'm not sure what the other information is, why that doesn't make it risk-informed. I mean, there is a strong sense of you're using the safety assessment to assist your identification of what components of the system matter, and then you would focus in on those.

CHAIRMAN RYAN: Okay. So they're using it to make judgments and decisions, and not just an analytical dose kind of number.

MR. McCARTIN: Oh, absolutely. Yes.

CHAIRMAN RYAN: Okay.

MR. McCARTIN: I mean, that's the part of intertwining that, that it should be used. You don't

go out and do characterization on a component that is not important.

CHAIRMAN RYAN: Okay. Bill.

MEMBER HINZE: Very quickly, I'm interested - do the separate components of the former Soviet Union - are they involved in this IAEA development of standards? We don't see much about that in terms of where they are with their geological disposal. Can you give us any insight as to what's happening there?

MR. McCARTIN: Yes. I mean, they are invited to the meetings. And as I recall, certainly Russia has sent representatives to meetings over the last year or two. And I know there's representatives from Yugoslavia, and I'd have to go back and look, but they are invited, and there is some participation.

MEMBER HINZE: Do you have any sense of where they are in terms of their geological disposal, and interest in following on these standards, and using the guidance and so forth?

MR. McCARTIN: No, that I don't know. These meetings -- well, they attend and they're part of the discussions. I mean, they engage in the discussions, and so there's a sense that there's some agreement with the principles and the requirements

that are laid out. But we rarely get into discussions in terms of what an individual country is doing. It's more, this is at a level - are these reasonable standards?

MEMBER HINZE: Thank you.

DR. GARRICK: Tim, could you say something about the investigative model that IAEA uses on addressing issues like this? And to make clear what I mean, is I'm thinking of the way the National Academy does things versus the way NRC and EPA does, and their different models. The National Academy gets information from its sponsor, and basically does a critique on it, and makes findings and recommendations based on that. The equivalent here could be that IAEA gets input from its member states, and does a similar exercise on them as the National Academy's does. Or is it more like the EPA and NRC, where it invokes a much stronger scientific input to it by interaction with laboratories and contractors, and what have you? I'm just curious as to how they approach document or an issue like this.

MR. McCARTIN: Well, for this particular document, they are getting input primarily from member states, and they have -- it's done in a couple of different ways. I mean, typically there'll be at

least one, if not -- for this there's a couple IAEA staff members that are in charge of the development of this document, and they will have really two types of meetings; one is a consultant's meeting, where they bring in a limited number of experts in the areas they are seeking to -- and those consultants generally help them write the document.

Then there's what they have, technical meetings, where a technical meeting is opened up to all member states to come and participate, and they're given the document, and there's possibly a week of discussion with respect to the document, and comments are provided, and then the process continues. There may be another consultant meeting to deal with the comments that were raised by the countries during the technical meetings, and there's that process, at the end of which at some point, there's a review process within the IAEA, that they have different committees. Some of the committees, I'll say the NRC sits on some of those committees. I mean, they're also composed of member countries all the way up to Marty Virgilio sits on the higher committee. And then there's debate on that document there, and so there's --

DR. GARRICK: So it sounds much more like the National Academy --

MR. McCARTIN: Yes, very much so.

DR. GARRICK: National Laboratory --

MR. McCARTIN: Oh, yes, yes, very much so. Yes, the technical expertise is pulled from the outside. Yes.

CHAIRMAN RYAN: Okay. Thank you. Tim, thanks very much. It's helpful to get these updates. I hope as you participate with the IAEA, we can call on you for similar briefings to learn what's going on.

MR. McCARTIN: Sure.

CHAIRMAN RYAN: It's very helpful. Thank you very much.

MR. McCARTIN: Yes.

CHAIRMAN RYAN: Okay. We're scheduled for a short break. We're just a few minutes behind, so we'll reconvene promptly at five minutes of eleven.

(Whereupon, the proceedings in the above-entitled matter went off the record at 10:40 a.m. and went back on the record at 10:55 a.m.)

CHAIRMAN RYAN: Okay. If we could reconvene please. Ruth, you're the introducer for this presentation.

MEMBER WEINER: Oh, yes. Let me organize myself here. This is the Review of Waste-Related Research for RES and I do not have on my -- This?

CHAIRMAN RYAN: That's it.

MEMBER WEINER: Thanks. Just got it. Welcome, Dr. Bill Ott and we look forward to your presentation. Now that I have --

DR. OTT: Thanks, Ruth. I hope that sets the tone for the whole talk.

MEMBER WEINER: You weren't on the schedule.

DR. OTT: I proposed this briefing because the last couple of times we've come down with project-specific briefings. It appeared that because there's been a large turnover on the Committee it might be useful for you to see some background as to how we got to where we are today and what the actual breadth of our current program is.

So there's a lot of history in this briefing and there's quite a bit of where we are now and there's a lot of what I would like to do over the next year in terms of interacting with you. So hopefully, there's a little bit in here that will bring us all up to speed and put us on the same page.

When this group started years ago, we were doing high level waste and low level waste research and of course, there was a time in the late '90s when that no longer became possible and the Office of

Research stopped doing high level waste research and the Office of Nuclear Material Safety and Safeguards stopped asking us to do low level waste research.

But there was a consensus in the Commission that we needed to be active in this area. because there were other areas with other things that were problems, decommissioning and environmental problems with reactors. We needed to know about radionuclide movement in the environment. So we developed a generic program that was based on those elements of the low level waste and high level waste programs which are not specific to those applications. What that means is things like high temperature geochemistry, volcanism we don't do because those are of use to nobody but Yucca Mountain. So if you have question about why we don't do certain specific things, quite often it's tied back to that historical perspective.

We do include general topics such as infiltration, flow, absorption, uncertainty and most of these things are just as relevant and of just as much interest to low level waste and high level waste. We try and keep NMSS and the Center informed of our progress and we, in fact, involve them as much as we can even though we know their basis for doing it is

high level waste. It doesn't matter as long as our basis for doing it is generic.

MEMBER WEINER: Could I interrupt you for a second? You still do research on radionuclide mobility of chemistry of radionuclides and so on.

DR. OTT: Yes. And that will be coming as we go along because we'll go through each of the topical areas that we look at. We coordinate with NMSS staff on decommissioning, fuel cycle and high level waste and low level waste. We inform them of progress. We even involve them in activities like MOU working groups. There's an MOU for research and development of multi-media environmental models which we are partnering with nine other agencies and we've involved the Center in working groups that act under that MOU.

We actually involve the Center in the sorption project which has a lot of high level waste interest from other countries as well. They were one of the modeling teams that model test cases for us in the sorption project. Our focus is largely on the near surface. I guess I ought to go through these slides, shouldn't I?

MEMBER WEINER: You're on the fourth one.

DR. GARRICK: You're reading from four and

he only has one.

DR. OTT: Okay. Sorry about that.

MEMBER WEINER: I think you're on Slide 4.

DR. OTT: This is what I'm going to try and do. I'm going to try and go through background. I'm going to try and give you a structure for the program. I'm going to discuss the topical areas that are described in that structure. That's going to be most of the briefing. Then we're going to talk about cooperation with NMSS and other Federal agencies in a little more detail and then we're going to talk about these proposed interactions that we want to go through within the next year.

This is the background that I was just talking to you about. Sorry about that. I wasn't coordinating between these two. And now we're on to this one.

Our focus is largely on the near surface supporting realistic assessments of potential exposure of the public from decommissioning and remediation actions. The Commission over the last ten years, even more so over the last five years, has migrated from the position of relying on conservative assumptions to becoming more and more realistic. So we're trying to support that need for tools that are closer and closer

to realistically modeling environmental systems which is no small task.

On sites where relatively simple tools and techniques can exist address existing conditions where there's temporal and spatial variability and chemical or hydrologic conditions, distributive source terms. These are the things we're worried about, those things that NMSS quite often refers to as complex sites. For the simple sites, most of the simple tools work. So we're really aimed at the difficult problems that face NMSS.

We do primarily cover user-need generated topics and we try to cover the full range of PA although there are some areas where what we're doing is limited at this time. I'll point those out.

This is a convenience. It helps us organize the program and identify the projects that are in each piece of the program. The colors on there in terms of red and green don't really apply as much now as they did in the past because our coordination with NMSS although always strong has actually improved. The things in here that are red indicate that they were initiated by RES staff because we perceived a problem but we hadn't received the user need on it.

As a matter of fact in our user need reviews now within NMSS, almost all this work is supported and they anticipate the results of it. So this is merely a convenience that when we first developed the slide showed which was user need and which was not user need. But all of it in fact is now supported by NMSS.

This just lays out the general structure of the problem. We know we have to worry about what's there in terms of source terms. So we're worried about source characterization.

We're worried about barriers because it's becoming more and more evident that barriers will be necessary even in a lot of low level waste and decommissioning situations.

The flow model is the basic mechanism by which we move things around. The reactive transport models are the things which help us assess what happens as it's moving. The transport calculation is just a box that represents the programs that we use to put all these pieces together, things like RESRAD and FRAMES, the platform models and the hardwired models that have all these components within them. Then at the bottom we use all these inputs to calculate concentrations and exposure rates and we use that to

assess the doses.

Then I have this thing sitting off there on the side which says "integrated groundwater monitoring" with arrows pointing every which way and what it means is that basically monitoring the problem which pervades the process. It's something that we need to worry about from the beginning to the end.

Now I'm going to go through each one of these pieces. Let's go slip quickly through these next two because here I just describe what's embodied in each one of those pieces and I think you probably know what's embodied in those pieces. So let's go into the pieces themselves and start talking about them.

Source characterization. Historically we've done a lot of work in source characterization focused primarily on low level waste. Most of that work ended around 2000. In 2001, 2002, the last of our products came out of INEL. I guess now it's INL, Idaho National Laboratory, looking at various characteristics of low level waste. We've also looked at slags at both PNNL and Johns Hopkins University. We had a long-running project here with one of our staff up there doing analysis slags. That report was issued last year, a final report on the slags. NMSS

is finding that useful and are calling our staff now about current slag sites to see how to handle the contamination they're seeing there.

MARSSIM Maintenance, MARSAME development, these are things that help identify where radionuclides are in the environment. Bayesian Subsurface Survey Methods, which is SADA --

MEMBER HINZE: Excuse me. What is MARSAME again, Bill? What does it do?

DR. OTT: MARSAME is the -- You got me.

MR. HAMDAN: Multi-Agency --

DR. OTT: There's MARSAME and MARSSIM and MARLAP.

MEMBER HINZE: But I've heard of --

DR. OTT: I can't remember what MARSAME is right now.

MEMBER HINZE: That's okay. What does it do?

DR. OTT: Cheryl's going to address this one.

MEMBER HINZE: Okay.

MS. TROTTIER: It's materials and equipment.

DR. OTT: Okay.

MS. TROTTIER: Basically it's the same as

MARSSIM but it's materials and equipment.

MEMBER HINZE: Okay. Fine.

DR. OTT: It's basically the way of measuring the radioactivity in materials and equipment.

MEMBER HINZE: Okay.

DR. OTT: For clearing it. So all this stuff is aimed at identifying radionuclides and the amounts present. SADA is basically a tool that's being used out in the field for determining distributions of radionuclides and it was focused first at the surface and now it's going subsurface.

The latest version is 4.1. It was recently issued in March of this year. A user's guide was issued in April of this year. There was training provided to the staff in March when the code was issued. It employs most readily available statistical methods and gives you ways of assessing how these methods would impact your choice of selection and of sampling of schemes for sites and how efficient they would be.

We're just starting a new phase of SADA Work. The developmental tasks and the follow-on projects are listed on page nine here. They're trying to incorporate soft information including uncertainty

directly into estimation using Markov Bayes II techniques. They're trying to develop a direct interface with an incorporation of geotechnical data. They're going to provide 3D variogram maps in the newest version.

They're looking at a method for optimizing bore hole location and sampling design. They have another task in there that's going to help estimate the likelihood of miss. In other words, if we use this particular sampling scheme, what is the likelihood that we will miss a significant contaminant or an area of significant contamination?

And they're trying to provide simplified implementation guidance which is basically a yes/no roadmap that allows you to go to each step and say, "If this is the case, I go here. If it's not the case, I go there." So they're trying to simplify the application process for using SADA to design sampling schemes.

The work's being carried out in cooperation with the Environmental Protection Agency. They were the original sponsor of FIELDS which was the predecessor for SADA. ACNW was briefed on this program in 2003 and I'm not certain how much overlap there is here on that briefing. We will probably

propose a detailed briefing for this fall and I think that would be a very interesting interaction.

MEMBER HINZE: Are you verifying this at some site or how is this --

DR. OTT: There is no field verification involved in our part of the program, but it's being applied at a number of sites and being tested by a large group of users. That feedback is coming back to us. So we're not doing a direct field test ourselves.

MEMBER HINZE: And these sites are appropriate to your problems then.

DR. OTT: Yes. Barrier performance is the next one. I think we've gone through this. Our barrier performance work has been focused at NIST. We started out a number of years ago. Let me back up a little bit. During the low level waste period, we did support work out at Beltsville on five lysimeters out there where we investigated cover technologies. That work continued even at a low level being monitored for almost 13 years and it's one of those cases where you wish it was still going on because it's the lifetime of these things beyond 10 and 15 years that's really becoming an issue now. But after that --

Those are primarily soil covers and we had a vegetative cover and there were five different

schemes that we looked at there. But parallel to that, we started to looking at concrete because a lot of low level waste disposal facilities were coming in with concrete vaults and concrete barriers, the concepts that were being advanced for these facilities. So we haven't built any recently.

And it became evident when we produced the PAWG publication in 2000/2001. Performance Assessment Working Group put out a fairly landmark publication on low level waste performance assessment and doing that it became evident that you really needed to have barriers to perform for a low level waste site to work. Otherwise you really couldn't meet the standards.

So it became more and more evident to us that we really needed to know how concrete behaved in the long term and we first looked for data and we couldn't find it. We looked for archaeological data on concretes and found out we couldn't bound the calculations because we didn't know the initial conditions of when they were set down.

It basically resulted in our going to NIST and saying we need to develop a program to assess long-term performance of concrete. We developed a model names 4SIGHT which may be familiar to you. It's

on the NIST web. It's the first of its kind model for evaluating long-term performance of concrete. We're continuing to work there to improve 4SIGHT and consider other possible degradation methods.

We're also working in terms of barrier performance in looking at clay barriers. I think at least one of you attended the seminar that was recently held, yes, in which Professor Benson indicated that he had done some extensive work on clay barriers and the problem is that they aren't working. We don't really know why.

Part of what we're doing with the Corps of Engineers is to try and figure out why. They've advanced a theory. They think one of the problems may be the practice that has been followed in laying down clay covers in terms of compacting them to the wet of optimum. They think that this practice may in the long term be detrimental when the covers tend to dry out. That's one of the things that they'll be testing in the work at the Corps of Engineers.

One other thing I should say is I have a lot of staff here if you have detailed questions. We may not have time to get to them, but they're here. Jake Philip is back there. He's the project manager in both the NIST work and the Corps of Engineers work.

The other thing that's fortunate about 4SIGHT is that we're now seeing applications which may include WIR where we're looking at solidification using cements and concretes and some of the work that's done there may be applicable to that. We also did work that was aimed at entombment before that option was put on the shelf and the research was designed for an ordinary conclusion. But we were looking at backfills and infills to include grouts which is another issues which may be pertinent to WIR.

The third application which happened very recently is that our people have been brought in to discuss problems leakage at spent fuel pools which to us looks like problems with microcracks as opposed to anything else. Microcracks is something that we've been very worried about for the waste disposal problems and failure of barriers at waste disposal sites.

MEMBER HINZE: What are they initiated by, these microcracks?

DR. OTT: I don't know what the initiation is. They just occur. Probably stresses in the concrete and shrinkage.

MEMBER HINZE: Even after a long period of time presumably, several decades?

DR. OTT: Yes. I mean we walk through structures and we see cracks in concrete all the time. The research concludes the current phase with (Cough.) based on the old entombment work concludes in mid 2006 and we're preparing to write a research information letter summing up all of that work in the middle of next year.

This is the Corps of Engineers waterways experiment station work that I referenced. It's aimed at long term performance of clay for soil covers. The Corps of Engineers recently briefed the staff here and their principal subcontractor, Professor Benson, was in. That was the meeting I was referring to a little while ago. That last bullet there is the failure of clay covers may be a result of dessication after installation wet of optimum. That's the point I made a few minutes ago.

There's an upcoming activity in the barrier performance area. It's something we started almost three years ago. There was a National Academy study which is looking at engineered barriers. We made our contribution to it but it was delayed for almost two years waiting for EPA to make their contribution. EPA made their contribution and now the Committee has been identified and the Committee

activities will commence this fall. There's a workshop planned for actually August 2005.

We supported the IDIP and the WIR workshops that ACNW put on. We sent staff down here to participate. We would like to probably prepare a briefing in the spring of 2006 on all the work that we've been doing in the engineered barriers area, the results of the concrete work and structures and infills and backfills. We have a research information letter as I said planned for March. So after we finish that research information letter, we would be in a situation to come in and give you a detailed briefing of the results of that work.

Flow models. You're all familiar with Tom Nicholson. He's the lead staff person involved with looking at flow models. We completed extensive work in earlier years at places like Apache Leap, Las Cruces Trench. We've involved investigators like Dan Evans, Shlomo Neuman, Randy Bassett at Arizona. New Mexico State, Pete Wierenga was there. Now he's at Arizona. We had Glendon Gee and Phil Meyer at PNNL and we've worked with Lynn Gelhar and Dennis McLaughlin at MIT.

Those are all historical references. That's the program as it was up through the middle of

1990s when essentially our resources were severely limited and we focused primarily on non high level waste. There's a lot of work in here that was done on unsaturated systems and saturated rock systems.

Since then, we've been focused on the near surface as I said in the opening and primarily on soils. We were still working with Shlomo Neuman through last year on conceptual model uncertainty. He's a subcontractor to PNNL and Phil Meyer on the continued work on uncertainty and flow models.

PNNL is currently working on developing an integrated approach to uncertainty including the parameter work that they did earlier, the conceptual model work that was done by Shlomo and an evolution of it to look at scenarios. So they're trying to incorporate all this together into one uniform uncertainty methodology and they're including in this application to existing field data. I can't tell you which field data but we are looking at field data but not doing field work to develop that data. So they're looking at existing datasets.

We're also working with Agricultural Research Service. They were in here a month or two ago and briefed you, primarily working on model abstraction. Other work at ARS is focused on more

realistic estimation of recharge in its incorporated hands-on participation by RES staff.

We've actually had Tom and Ralph, Katy and Adam Schwartzman working at NIST on a fairly tenuous basis, but they've been out there working in the field, working in the field on acquiring data. A lot of this work on infiltration actually was examining new techniques for measuring infiltration so we have a better handle on what we actually are seeing.

We're contracted with the Corps of Engineers to bring their Groundwater Modeling System (GMS) on board. This is one of the more robust packages out there and we brought this in and provided training for NMSS staff so they can use GMS on the field sites that they're involved with. GMS is also being incorporated into FRAMES through another contract with the Corps and our work with PNNL.

We have some tentative follow-on areas identified, comparison of simple to complex flow models using the areas of watershed database and coupling of integrated uncertainty methodology to monitoring. We've been integrating all these things and monitoring and measurement seems to be a key issue in here, how do we confirm what we've measured, how do we confirm what we've predicted, how do we make

monitoring now consistent with what we did in terms of site characterization before. Because if you can't connect the two of them, it's sometimes quite difficult to understand what's actually happening.

Interactions with ACNW, we had the recent briefing by ARS in 2005. We had a briefing by PNNL in 2004. That would have been Phil Meyer and Shlomo were in. We don't have any additional briefings planned at the present but probably after the end of the 2006 year we'll be probably be in a position to come back and give you another progress report.

Reactive transport models. This is another area where we've had an extensive amount of work and work that built on the things that we did starting with high level waste. We actually did a lot of work on elevated temperature geochemistry before we got out of the high level waste program. At the present time or since we became a generic program, we've been focused on two contractors, Sandia National Laboratories (SNL), Randy Cygan, Hank Westrich who was involved for awhile, Pat Brady and the US Geological Survey (USGS) with Jim Davis out at Mineral Park.

Sandia has been attacking the problem from a more theoretical perspective. Jim has been looking at from a more practical perspective. Jim became

involved with this first again during that period of high level waste/low level waste through the Natural Analog Project in Australia at the Alligator Rivers, the Koongarra uranium ore deposit in the Koongarra Rivers area and he's been working with us ever since.

It's been fortuitous because the work that he's done has enabled us to actually make some practical steps in the last couple of years towards actually having models that can be incorporated in performance assessment models which allows us to do something more than just a simple KD. The model that Jim is using is what he calls a generalized composite (GC) model. The approach that's being followed more at Sandia is what you would call a component additivity (CA) approach.

Incorporation of these models both into a PA models should be the same. The difference is really in how you support them with data. Jim's approach still requires certain amount of site-specific data. The Sandia approach would also require site-specific data but it might be a different kind of data.

The field site that Jim did his demonstration work on in his generalized composite model was in Naturita, Colorado. He's also done some

work with it at Cape Cod. The fundamental modeling work has been doing at Sandia.

Jim has also been involved with us in helping to organize and implement the OECD/NEA Sorption Project. Phase I of that project was a consensus effort because a lot of countries in the world have been doing a lot of geochemistry work for a long time and they weren't seeing any benefits from it in the PA models. They said, "Should we really keep following this line of investigation or is this a case of diminishing returns where no matter how much money we're going to invest we're never going to get a result?"

So the first phase of the NEA Sorption Project was a feasibility study and the conclusion at the end of that study was that there's been a lot of progress made and we actually may be on the threshold of being able to do some practical implementation of more realistic sorption levels.

So then we went to Phase II and Phase II involved a lot of test cases where the 12 countries that were participating in the NEA Sorption Project provided modeling teams. This is where the Center for Nuclear Waste Regulatory Analyses (CNWRA) came to. They provided one of the modeling teams for our

participation. The USGS provided another modeling team. The Joint Technical Committee overseeing the technical work of the project provided test cases for these modeling teams to then model.

The final report of Phase II is planned. It should be coming imminently, probably in August. They're planning a workshop for October and following the workshop, they're going to have another one-day workshop to consider whether there should be a phase III to the project.

We also initiated an MOU Working Group on Reactive Transport. Jim Davis provided the proposal for that and it was approved by the steering committee. We last year had an international workshop at Sandia. It involved almost 100 experts on geochemistry from around the world. The proceedings of that are attained at iscmem.org website and there was an article that came out of it summarizing the results and the recommendations of the workshop.

Ruth had made an observation that we seem to be doing almost all of our work at humid area sites and for variety and to show an arid site, this is Naturita.

MEMBER WEINER: It's not humid.

DR. OTT: Definitely not humid. At this

particular time when I took those pictures, it was really dry and really hot. This is actually a site of a former uranium mill that's been remediated and they actually took off all of the dirt from the site down to the water table and then they brought in clean fill dirt and all of this area that you see there in brown is the area that was filled from the former uranium tailing site.

There is still uranium contamination on the site. The chemistry is fairly complex. The flow system is reasonably complex which is why we selected it. I told Jim we needed to find a site that wasn't so simple that you could argue that there were other things pertaining or other ways to solve it. He studied the site for a number of years because actually -- Well, I guess you can see it on there. This was taken during one of their field campaigns and they have about 40 wells drilled along here and they were in the process of drilling wells. Those are the field units they had on the site down there on the right. I just wanted to break up the presentation with a bit of color.

Current status. USGS feels they have demonstrated the utility of their generalized composite approach at Naturita. They're now working

on extending it to other radionuclides and also trying to use it at a more humid site at Cape Cod.

Sandia is encoding the generalized composite approach and the component additivity approach is using USGS RATEQ for inclusion in FRAMES. So we're actually moving now to include this in one of the major platforms that we're anticipating using in performance assessments at these complex sites. That work should be completed by this fall. At least the first phase of it will be completed by this fall which is a fairly simple code that allows us to tell whether we really do get a benefit from doing a more complex treatment of the geochemistry issue.

I've already mentioned this. Participants in the NEA Sorption Project will meet in October to consider development of a phase III. I mentioned the international workshop. Our future focus may be on the data needed to populate these models if we are indeed successful in incorporating them into FRAMES.

One of the problems that's been observed by the Licensing Staff here is that they will get a licensee coming in and wanting to use a surface complexization model because it benefits them in the long run. It shows lower concentrations and they don't have to do as much clean-up. The problem is

that they haven't really implemented the models correctly. They've tried to populate them using the wrong data and they need guidance on exactly how to use the models, when to use the models and what information to use in them and some cases we need more information to apply them if we don't have enough data.

ACNW interaction. I actually like to bring these people in this fall. The Sandia project, the current phase is ending. The NEA Sorption Project current phase is ending. We have the results of the MOU workshop and a lot of the results from Jim Davis's work and I would propose to bring in all of those people for probably a half day presentation sometime this fall if the Committee has the room for it on their schedule. I think it would be a very interesting discussion.

MEMBER WEINER: I think that would be a very good idea. We will look at the planning and you let us know what would be a convenient planning timeframe.

DR. OTT: Yes, I've already talked to Sandia since their contract is ending. We're going to give them a no-cost extension to at least make sure they're available and save a little money so they can

come in.

Transport calculations. The primary vehicles that we're working on right now are RESRAD. We're doing this primarily as support for NMSS. We made the original RESRAD probabilistic. From my perspective, the biggest problem is that RESRAD is generally a hard-wired code and they have a different version of the code for every particular instance.

Right now, they're working on a RESRAD-OFFSITE for offsite contamination. We're supporting that because it's a very widely used model and the staff here is very familiar with it. So we're trying to at least improve the tools that they have to work on for some of these sites.

The other area that we're looking at is FRAMES. I gave you some history here, didn't I? I'm actually down at the bottom when I talked about the current focus on RESRAD-OFFSITE and FRAMES. The beta version and manual release in October 2004, that's last year for RESRAD-OFFSITE. FRAMES 2 incorporating MEPAS, GENII and 2MRA modules from the EPA and a preliminary linkage to GMS was released in March of this year. We're currently working on a more robust connection to GMS. The first implementation was a rather simple connection of the two.

Future products. Again, I mentioned that we're working on modifying RESRAD-OFFSITE to enable a wider range of site-specific exposure scenarios. We're looking at more realistic treatment of reactive transport and improved linkage to GMS and FRAMES.

We have a very small project that one of our staff members is doing in trying to develop more realistic values for the fish consumption pathway for all of these models because there were some really big questions about the assumptions in the fish consumption model. We'll revisit that one when we finish. We're pretty close to having the write-up for that and we'll send it down to you when we send it to NMSS.

We plan training for both RESRAD-OFFSITE and FRAMES 2 in FY 2006. We're probably looking at a briefing on FRAMES 2 in the winter of 2006. So we're putting that one off a little bit. Winter of 2006, I have to talk to them about whether it's this winter or next winter.

Dose assessment. This is the work that was briefed to you about a year ago. I'm not certain exactly how many of you were present then. This is the work of PNNL where we've gone in focusing -- This is focusing on changes or improvements to the dose

models and this is the Biosphere Pathways Study. It was initiated at PNNL, examining assumptions, supporting data in the food chain pathway analysis and it was supposed to identify areas where new data might be necessary either because old data was of questionable value or because we needed it to support a more probabilistic approach.

We've discussed it with ACNW in February of 2004. You sent us a letter and suggested we change one of our radionuclides and we did that. Research being at zero of some function, we also had to delete one. And we sent you a letter back explaining what we were doing. We dropped nickel and added americium which is what you suggested that we do.

The current focus is on soil and water samples from three different areas and soil types for the study of technetium in crops including onions, corn, potatoes and alfalfa. There's collaboration with Oregon State University. One of the staff told me I needed to make sure, I should write it out, but at the time, I didn't have room on the slide, for uptake studies in fruit and nuts, apples pistachios, apricots, pecan, pomegranates, grapes and carobs. Don't ask me what the rationale for each of those is but that's the suite of nuts and fruits that they're

looking at currently in their project.

The principal investigator for this project, Bruce Napier, is participating in the IAEA program to update plant and animal transfer factors. That's an update of IAEA TRS-364.

Upcoming activities. They intend to extend the plant studies to include americium and neptunium. They are considering proposals for animal studies in Russia. We've gotten proposals both from Mayak and from Kazakhstan. No decision has been made on that. Sometimes it's difficult to do cooperative work with groups in the former Soviet Union.

There's a new NUREG/CR report on soil and water analyses and agricultural data which we expect this August. So next month, we'll have the first actual publication out of the project. We don't have any further briefings planned at this. But again as the project evolves more and gets to the point where we think it would be relevant, we would propose something.

The monitoring work is work that was started under an RFP. It's not generally been required for decommissioning sites to satisfy the requirements for unrestricted release. In cases where unrestricted release is not possible, monitoring to

assure sure compliance may be necessary.

The project was initiated through the RFP process. The contractor is Advanced Environmental Systems (AES). They're incorporating information from site characterization, performance assessment and site design. They include concept to performance indicators, measurable parameters that can linked to features or models that may mirror or anticipate site failure and test performance assessment.

This whole approach acknowledges that early detection is more effective than detecting after failure. We're trying to find some way of advancing the point of which we find out that we need to do something, something to fix the problem because it's always easier to fix it earlier in the failure process.

They've developed a methodology for the design of the monitoring program. Their current focus is on applying that methodology to existing datasets. Their future activities are focused on coupling integrated uncertainty methodology to monitoring and we're planning a briefing of the ACNW in the fall of 2006. So that would be about a year from now we would plan to come in and brief you on the progress on this work.

That's basically what I intended to do in terms of going over the pieces of the program. Now I want to talk a little bit about how we're interacting with others.

As I mentioned earlier, our interaction with NMSS has always been pretty strong but they've actually gotten better in the last couple of years. We've begun establishing technical advisory groups for some of the work that we're doing. The one on assessing uncertainty and in groundwater performance and monitoring, we've established technical advisory groups for both of those which involve NMSS staff. They meet periodically to look at what's going on both in the literature and in the project itself to see whether there should be changes or adjustments in the work.

We're beginning to see technical assistance requests from NMSS for our staff supporting their staff in some of the licensing activities which we view as good because it brings our people closer to the actual work that generates the research needs and specifically, we've been involved in the Integrated Decommissioning Improvement Program (IDIP) which is the one that's supposed to come out with new decommissioning guidance in the fall or a revision of

it. They've asked us for help with WIR, with West Valley and Shieldalloy. So we're beginning to get our staff more directly involved with some of these NMSS projects.

At the management level, we have quarterly meetings with the Environmental Protection and Performance Assessment Directorate in the Division of Waste Management and Environmental Protection in which we go over their user need, we go over the progress of our research and the products that have come out and we discuss whether there are additional areas they would like us to focus. When those are major things, we ask them to try and document it in a user need that would come to us directly from either the division directorate or the office.

With regard to other Federal agencies, about four years ago, we embarked with five other agencies in this MOU on R&D of Multimedia Environmental Models. It currently supports working groups on software, uncertainty, reactive transport. There's a four one on watershed modeling and a fifth one was proposed on urban air transport.

The fifth one is up in the air right now. It's up in the air because we tentatively had interest from the Department of Homeland Security in joining

the MOU and between a laboratory in the headquarters, a conflict evolved and they decided not to sign the MOU. There's still some interest in NOAA who is another participant in the MOU in working on this urban air transport modeling and that working group may still get established.

The original six members were NRC, DOE, EPA, Corps of Engineers, U.S. Geological Survey and the Agricultural Research Service of the Department of Agriculture and amongst those six, we probably involve the largest group that are working heavily in developing the kinds of tools that we need at the NRC. I can't name off the top of my head the other three that have joined since then. All I know is HS didn't work.

One of the other things that we've done with other Federal agencies is cooperative funding of National Academy projects such as "Assessing the Performance of Surface and Subsurface Engineered Barriers." This the project that I mentioned earlier in the discussion on engineered barriers where it's taking us almost three years to actually get the committee started. But EPA has come through and DOE are both funding this particular project.

This just lists the agencies that we're

involved with to a significant level. EPA, Corps of Engineers, USGS, Agricultural Research Service, we're all heavily involved with those and to a lesser extent with DOE but of course a lot of our contracts are with DOE labs. Those actually are the core agencies for the MOU.

International participation. We're involved with the Integration Group for the Safety Case which is an OECD/NEA activity, the IAEA-ASAM project with its application of safety assessment methodologies, the working group on the "Role of Conservatism versus Realism." The IAEA-EMRAS project is being supported through our contract on biotic pathways, the Phil Reed project and of course, OECD/NEA Sorption Project which I already mentioned.

Here I've summarized what I alluded to as we went through the briefing. These are the things that I would propose for us to do. The only thing I have to clarify is whether the winter of 2006 is the coming winter or the following winter. This fall I actually have three or four things we could come to you with. I think the most exciting would be to look at the geochemistry work. That's all in this first bullet.

The SADA, I think SADA would be a very

interesting briefing for you too, the winter briefing on FRAMES, the spring briefing on concrete work and then the fall briefing in 2006 on the results of the integrated monitoring project. I realize you have a busy schedule. I just thought I'd sort of get on the board as saying I think this is the work that would be right to bring to you over the course of the next year or so.

MEMBER WEINER: Thank you very much I thank you especially for giving us a heads-up on the work you'd like us to see. I know we're a little behind schedule but I also know the members have questions. So I'm going to allow some time for questions. Dr. Garrick.

DR. GARRICK: I'm not a member.

MEMBER WEINER: Well, former member.

DR. GARRICK: Thank you very much.

DR. OTT: He's had his chances before now.

DR. GARRICK: Yeah. Bill, I have two questions. I have a lot of them but I'll try to boil it down to two. This was an excellent overview of the program. But the thing that occurs to me, this is a technical advisory committee and I think that there would be a great deal more interest on the part of the committee, and I'm saying a little out of order by

saying that, if they were a little more engaged on the technical issues associated with the program rather than just programmatic information.

For example, the NUREG-1573 was basically done during my watch. If I had heard a detailed presentation on that work, I'm sure the Committee would have offered a good deal of advice on some very important issues. As far as I know, we didn't get that level of involvement. I think that's a missed opportunity and that's one comment. I just think that the Committee ought to be much more engaged with respect to the technical issues behind this work rather than just the programmatic aspects.

Second, I'm wondering how you are getting value from your research. I'm wondering what activities are going on that propagates the benefits through the business. Again, as far as I know and NUREG-1573 is a very valuable piece of work, but as far as I know, there have been no takers on it. I think that's unfortunate. So I guess the second question is what do you have going on that really stimulates interest in what you're doing such that the results of your research becomes involved in applications.

For example, one other example, the

foresight. What have we learned about concrete performance and lifetime as a result of the application of foresight? So that's basically my comment.

DR. OTT: Okay. I'm going to punt a little bit on 1573. 1573 started out as a branch technical position in NMSS that we were helping through our participation on the performance assessment working group and when the Commission really stopped doing a lot of low level waste work, they backed out of making that into a branch technical position because it would have had regulatory oversight. And the publication has handled through NMSS. So to a certain extent, we didn't have a choice on whether that stuff was brought to you guys.

I thought at some time we had briefed to you on or the Committee had. I agree with you. It's a landmark document.

DR. GARRICK: Yes.

DR. OTT: And really was the first really publicized attempt to take all the work that's been done on high level waste on applying probabilistic methods and apply it to low level waste and more mundane or more surface-related analytical problems.

I was over in Europe probably in the late

90s talking the French and they were adamantly opposed to the approach that was being proposed in NUREG-1573. They were able to defend their work with deterministic models and they didn't want anything to interfere with their success of doing that. I think our response was we think this is the way to go and it's going to happen. I would hope that eventually the techniques in there will become pretty much standard and I think a lot of people in this country accept it. I think it's getting a lot of reference.

With regard to us, the other point, that's one of the reasons why I'm proposing these briefings for the ACNW to try and activate a more active dialogue on the technical level. This one was prompted just because it was clear with a lot of people that were new to the committee that they didn't have any sense of the history and that's what I was trying to give you that sense of the history as well as the breadth of the current program and then propose ways that we could come in and give you that detail. So I guess what I would say is I'm trying to address the problems you identified.

DR. GARRICK: Thank you.

MEMBER WEINER: Dr. Clarke?

MEMBER CLARKE: Just a comment and a quick

question following up on what John said. I'm very interested in all of these topics and I'm particularly interested in the one where you're looking to identify precursors. I'll call them precursors to failure, the AES project. Can you tell us a little bit more about that and the status of that?

DR. OTT: Unfortunately, Tom Nicholson is the project manager and he isn't here so I can't give you a whole lot on that. He's been working very closely with NMSS to try and identify what you'd call performance indicators. These indicators are things that can be measured. So we're trying to get away from the abstract of let's measure water, let's measure this, let's measure that and then let's do a model and let's see whether things are performing.

Let's figure out what parameters, what things, we can measure to tell us right away whether we're working right. I wish I could give you a better answer but by all means, feel free to contact Tom. His email is tjn@nrc.gov.

MEMBER CLARKE: Thank you.

MEMBER WEINER: Dr. Ryan.

CHAIRMAN RYAN: Bill, thanks for a really informative briefing. I agree with the previous comments. It really is a nice overview and again, I

second John's comment. If I look up at the schedule, I see a lot of results, results. What I would suggest is it would be really nice if we could take each meeting and split it in half and talk about results of something that's current and then maybe also the forward-looking view of here's our current view of a given research topic that's upcoming for maybe the next meeting so we can give you some more timing input on things that might help you even steer the research.

So a little bit of a mix and match there would probably be a good way to address it because clearly you don't want to run each research proposal through us. But if we can get involved early on, the americium example you mentioned, that's one where I think we added just a little bit of value on a key radionuclide that will be good information. But if we could see maybe the results of one and the forward view of the next project, that will keep us current with your activities as well as give us an opportunity to weigh in if we see something where we think we can add value.

DR. OTT: I appreciate that. I guess one remark I would have to make is every committee is different and some committees are more interested in getting it one point or another point. On the other

side, we're looking at it from the point of view of is it ripe yet and sometimes we think it's not quite ready. It's not ready for public consumption.

CHAIRMAN RYAN: Well, and again, I think the idea is we can offer you technical insights from our vantage point that can be helpful or further encourage the work or even offer the idea that maybe some work should be expanded or enhanced or perhaps not, whatever it might be, that's the stage where I think we can offer the best benefit.

DR. OTT: I appreciate that.

CHAIRMAN RYAN: And that's not to say that we're not interested in results. But maybe we could plan the meetings along this rough schedule with a little bit of both.

DR. OTT: Yeah. I should also say that is what I've done is I've proposed some things to talk to you about and some schedules here. But I've laid out the entire program. If you guys see something in there you'd like to hear about on a different schedule or earlier, call us and we'll see what we can do.

CHAIRMAN RYAN: One example along those lines that I'll just turn your attention back to 22, it was something that we talked about yesterday on our Decommissioning Working Group follow-up. We always

talk about monitoring on one page and we talk about modeling on the other page.

In case like this where you're doing performance demonstration of some kind, there are always two components. One is there's a compliance requirement of somehow measuring something and we'll say, "Yes or no, you've complied." But I always view the monitoring as a two-pronged value. If I monitor it right and perhaps don't look at just the radionuclide concentration in the water for example, but I measure the water level and further make my dataset more robust for my groundwater modeling effort, you can get two things for maybe the price of one and a half or one and a quarter.

So that's an example where I think if you're talking about you're monitoring a research project, we could maybe help. It seemed to make some sense to the Decommissioning folks that we could add some value by having those kind of discussions that are maybe conceptual and in advance of your formal program implementation for a particular project. So just a thought.

DR. OTT: Well, as you can see here, we're about a year down the way from you. But if you want to hear from us on this project this fall --

CHAIRMAN RYAN: That might be a good example to start with as one that's a little bit forward-looking and we could maybe exercise our thinking here on that project. That might be good.

DR. OTT: And I certainly think the project is aimed at integrating all these things.

CHAIRMAN RYAN: Yeah.

DR. OTT: Integrating performance assessment, integrating site characterization, integrating monitoring.

CHAIRMAN RYAN: Sure.

DR. OTT: Developing an internally and self-consistent set of measurements and analytical calculations.

CHAIRMAN RYAN: And again it treats it all as a system rather than individual parts.

DR. OTT: Exactly.

CHAIRMAN RYAN: Which is the key to risk informing.

DR. OTT: That's right.

CHAIRMAN RYAN: Yes, that might be a good one. Thanks.

MEMBER WEINER: Allen?

VICE CHAIRMAN CROFF: Good presentation and I'll just offer a comment to reinforce some of

which you've already heard. I would like to hear about the monitoring thing and the concrete sooner rather than later if it makes any sense at all.

MEMBER HINZE: Well, I will fifth the comments about the usefulness of this but also I believe the Committee has previously spoken about how great you're doing in terms of propagating your rather meager funds by joining in with others and that's a very useful thing to the Commission.

I want to second and third my colleagues in terms of monitoring and concrete learning about those earlier on the game than simply the results. I'm wondering, Bill, if you have, a couple of things, an annual report that summarizes. Does your section provide an annual report on the research work that is ongoing and the results to-date?

DR. OTT: No, actually we don't.

MEMBER HINZE: Okay.

DR. OTT: But one thing I have that I provided to Dick Savio, I sent him an email. I told him that I would try to put together a reference list for the products that have come out of the section over the last five years.

MEMBER HINZE: Well, that was going to be my next question. Because if we're going to identify

areas that we are particularly interested in and we think would be useful for reporting to the Commission, it would be very helpful for us to at least know about interim reports from your contractors and is that possible for us to receive those? Are you sending those to the ACNW or does the ACNW know about when --

DR. OTT: You mean the monthly status reports?

MEMBER HINZE: Yes, status reports, interim.

DR. OTT: I think you would get snowed under if you say all the MLSs that came out of the contract.

MEMBER HINZE: I don't think we want to see all of them but I think that it would be helpful to know what is out there and to pick and choose on the basis of our interest and concerns.

DR. OTT: We've probably not been in the common practice of sending you interim. We sometimes get letter reports that we send to NMSS. But we could certainly increase the distribution of those which probably do serve the function of progress reports. They're informal and they aren't published so they're not really accessible. We haven't really been sending them to the ACNW. To a certain extent, since they are

preliminary, you couldn't release any of the information but that's something you know. But I'll see if we can't do a little bit better in terms of getting you some of those interim products.

MEMBER HINZE: It would be very helpful for us in terms of identifying things that we would like to talk to you about or we would like to hear about.

DR. OTT: Sure. We do have you on distribution for all the NUREGs that come out. I think we got you enough copies for everybody on the Committee. So you should each be receiving a copy of all of our NUREGs and should have gotten three or four of them just recently.

MEMBER HINZE: Well, I'm sure that I have not received them and I certainly would like to know what's available.

DR. OTT: That's interesting.

MEMBER HINZE: This reference list that you're providing to Richard, will that be an annotated reference list that will give us more than the title to guide us as to the degree of our interest in it?

DR. OTT: No, it's not annotated. It's about ten pages long as it is. It is divided up according to the structure of this briefing.

MEMBER HINZE: I see. That's good.

DR. OTT: And I've organized it according to year starting with the most recent year. So the publications in 2005, 2004, 2003, they're all grouped together under these headings that I've used to divide up the briefing so that you could associate the publications with the work that we've done. That should probably satisfy a little bit of the annotation problem.

MEMBER HINZE: And we harass Richard then if we're interested in one or more of those?

DR. OTT: I would really love to see that happen.

MEMBER HINZE: Well, one could only continue to aspire devoutly to be wished. This listing of the times on page 25. Dr. Ryan has already alluded to results, results. I assume that these are based upon when these are reaching some kind of milestone where you think it's worthwhile or are these the termination of the project or how was your choice on these?

DR. OTT: My choice for the geochemistry one which is the first one is based on my view that a lot of threads are coming together. The current Sandia work is ending with the productions of some

tools to go into FRAMES. The current stage of the NEA Sorption Project is ending with consideration of another phase to it. The MOU Reactive Transport Working Group had that international meeting about a year ago which Jim Davis was working on.

The USGS project is more in the middle but we're still at the phase where we think we've made a demonstration of the utility of the work. So with those other pieces ending and Jim's piece being in a stage where he's made some demonstration, I thought this is something that's really relevant to bring to you guys and give you a full-blown opportunity to look at what we've done and what we're still doing and there is the consideration of with the current phase of the Sandia work should really continue to do work in that area. Right now, the budget does not include resources for continuing the Sandia work in the next fiscal year. So this is actually a very good time for us to bring that work to you.

The others I went to the project managers and asked them, "Do you think this stuff is ready to bring down to ACNW? Do we have enough information to give them and would it be in a state where we could get benefit from comments back?" So to a certain extent, I'm relying a lot on the staff on some these.

The initiative on the geochemistry briefing was mine. I was the one that decided that I thought it was really time to bring that to you.

MEMBER WEINER: We're a little bit behind schedule so I'm going to cut the discussion short.

DR. LARKINS: Ruth, can I make one comment?

MEMBER WEINER: Dr. Larkin.

DR. LARKINS: I was going to say. I'm sorry I missed a lot of it, but I think it would be worthwhile for us to make a compilation of all these activities over the next month or so and put it on one of the retreat items so we can treat it more systemically in folding this into the work plan for the Committee for the coming year.

CHAIRMAN RYAN: Absolutely.

MEMBER WEINER: That's a very good suggestion.

DR. LARKINS: And do that as part of the retreat.

CHAIRMAN RYAN: I think it would be very good to get things into our schedule as well which is very helpful to you I know, having an anticipated schedule for you and for us as well.

DR. OTT: I've tried not to overload you.

I think I have two for this next quarter and one for each of the following three quarters.

CHAIRMAN RYAN: Well, as you pointed out, you're pulling a lot of the strings together for different components of the agency and some of these projects are crosscutting and important and we're happy to hear about them.

MEMBER WEINER: And when we do plan them, I hope we can plan enough time so that everybody's questions can be brought up. Anyway, having said that, all my questions were already raised. Thank you very much for an excellent briefing and we'll get back to you on all of the scheduling of all of these.

DR. OTT: Okay.

CHAIRMAN RYAN: Thanks, Ruth. We're scheduled for a lunch break now and we will reconvene promptly at 1:00 p.m. and we'll be off the record until then. Thank you.

(Whereupon, at 12:03 p.m., the above-entitled matter recessed to reconvene at 1:09 p.m. the same day.)

CHAIRMAN RYAN: Allen will back in just a minute and Bill is here. So we'll go ahead and get started again. I apologize we're a few minutes late. We had a long lunch meeting.

And welcome. We are here for a presentation on Collective Dose from RES. And we are welcoming Terry Brock and also Cheryl. Welcome back again.

MS. TROTTIER: I just thought that since this was a research briefing that it would be good to not just so to speak throw Terry to the wolves here. And tell you a little bit about why we have someone from the Office of State Programs presenting a paper that was basically authored by Research.

A few years ago, the office developed a research plan to address radiation protection issues.

And within that plan are a number of topics, this being one. And Terry is a new member to the NRC staff. And while he was in the Intern Program -- you are out of the Intern Program now, right? Yes. While he was in the Intern Program, he came over to the Office of Research on one of his rotations and told me he really would like to do this paper that we had written into the plan on the discussion of the role of collective dose.

So I was pretty excited about that. And actually having Terry in the office was a total joy. He is a very good scientist. If there was a way I could have stolen him away from the Office of State

and Tribal Programs, I would have done that. But I was unsuccessful in that bid.

But anyway, I did invite him to present this paper today. And he willingly accepted doing that.

I just want to tell you a little bit about, you know, what we're really hoping to achieve with this. This is a very early stage on a discussion of something that at least in my mind is something that we have a chance at solving some of our problems with LNT.

I think -- you know, I guess for the sake of the transcript, that linear non-threshold hypothesis would be good. For those of you who are familiar with the BER-7 report coming out recently that reaffirms that the hypothesis can still be viewed as valid.

In my mind, we're many, many years away from having strong enough research to permit regulatory bodies to abandon this hypothesis. But yet there are other things that could possibly be done. And currently the way we use collective dose in regulatory decision making and what has been a criticism over many years is this issue of microdoses to megapeople.

And there is a way that that can be addressed. And so what we're hoping to do with this paper is really just simply put some ideas on the table that maybe people can start to think about and maybe at some point come up with a solution.

So with that, I'll turn it over to Terry.

DR. BROCK: Thank you, Cheryl.

As she said, we're going to try to get the ball rolling on this issue. We're looking at this issue from this general purpose that we want to provide information to the Committee to facilitate discussion on this issue. And really just get started.

As I go through the presentation, we'll present the options that we've developed without a selection of a favorite option because at this point, I think it's a bit premature to go one way or the other until this has been vetted more thoroughly throughout the staff.

The background, we use -- at the NRC use collective dose in decision making in a number of areas. One of the more prominent areas is in the value-impact analysis area or cost-benefit analysis area when we're developing regulations to support the regulatory analysis process.

In some cases, as Cheryl spoke to, the individual doses that are calculated are very small in the population. We have a very large population so you can end up with a collective dose that is quite large.

And then NRC bases our estimates on the radiation risk on the linear no-threshold dose response hypothesis or model. And this means that any potential dose, no matter how small, is taken into account in the collective dose calculation and any subsequent risk assessments that are performed. And ultimately in the cost-benefit analysis.

Just for background so we're all on the same page, collective dose per ICRP and NCRP -- you have your equation here. Your S refers to the collective dose to the population at risk. And H_I is the per capita dose of subgroup I, and P_I is the subgroup I of population P.

Qualitatively, it's the sum of individual doses received in a given period of time by a specified population from exposure to a specified source of radiation.

And then corollary to LNT dose response model when used to calculate health risk.

We broke out how collective doses is used

at NRC into two bins, two domains. One is the retrospective domain. This is where we're looking backwards, looking historically backwards at doses that have already occurred. Usually the data is provided in dosimeter readings. The population that you are considering is usually well defined in time and space.

And the examples that we have here is our REIRS database -- I believe that stands for the Radiation Exposure Information Retrieval System. That's where NRC licensees submit their annual dose data for their employees for tracking.

It's also used in looking at job iterations at nuclear power plants. When you see -- you can calculate collective dose after a job has been completed. And you can compare that from job to job. And it's a pretty useful metric for measuring ALARA in that context if you can keep your populations somewhat consistent.

And the focus of this talk and the thinking on this presentation is more in the prospective domain where the events or doses have not occurred yet. So we're looking forward. The population at risk, it's not always well defined spatially or temporally.

Examples would be the Reactor Level 3 PRA Consequence Analysis planning that we do in safety and security. And then in reg analysis such as the value impact or cost-benefit analysis. Again, that's the focus of this talk. And the following options are meant to address that domain.

The first option that we came up with was to truncate an individual dose at some nominal value. Truncation is an A Priority decision that you make that you are going to exclude certain individuals from the collective dose calculation based on a dose value. Or you can do it at some distance from a facility. Or at some future time.

NCRP, at one time, they had recommended that individual doses at one millirem per year could be excluded from the collective dose calculations. But that's been retracted.

NCRP, along with ICRP, now explicitly states there really are no theoretical reasons to exclude any individual doses, no matter how small, from the collective dose calculation. But there may be practical reasons to do. Important practical reasons.

The advantages of this approach, this would address -- truncating at some nominal dose would

address the concern of large collective doses from the many small individual doses over very large populations. That would address that concern.

We already spatially truncate in some applications of collective dose at one, ten, and 50 miles respectively, setting a precedent that truncation is acceptable in certain contexts.

Disadvantage, if you're using the truncation at a dose value, whatever value you pick, it may be difficult to justify the value selected because, again, there is not theoretical reason to truncate the individual dose from the collective dose calculation.

And depending on what value you select, I've seen in the literature suggestions anywhere from one to 25 millirem per year. At the higher levels, if there is an ALARA component, you would have to address that.

This second option that we found was the Health Physics Society position on collective dose. And this is taken out of the Radiation Risk and Perspective Position Statement that was just reaffirmed and changed slightly just last year.

In this position piece, the Health Physics Society says that for populations of which almost all

individuals are estimated to receive a lifetime dose of less than ten rem lifetime, you really should think about not using collective dose to estimate risk, the population health risk. Before it was all individuals. Just last year it was changed to almost all individuals.

And another excerpt from that position is that the estimation of health risks that are associated with radiation doses that are similar magnitude to the natural sources should be strictly qualitative and encompass a range of hypothetical outcomes, including the possibility of no adverse health effects at such low levels.

Advantages that we saw, the health risks implied by a collective dose calculation would be less uncertain if almost all of your individuals had doses that were not less than ten rem lifetime. This would, again, address the concern of the over-aggregating of many small, individual doses over very large populations.

Disadvantages, from an NRC perspective, it would have a challenge in accounting for the medical exposures that you have to take into account for determining lifetime exposures. We don't track that here. It would be difficult.

CHAIRMAN RYAN: It's not tracked.

DR. BROCK: And on the second piece, an approach -- to use the qualitative descriptors of risk would be difficult to develop and use. And how that would be used in cost-benefit analysis would need to be explored.

The third option is the individual dose emphasis. So this emphasizes the protection of individuals in the critical group of the overall population, of the exposed population. And there is an assumption that if the average individual of the critical group is protected, the entire population is protected. In this option, there is no collective dose calculated.

I like this graph. I took this from NUREG-1640. I think it demonstrates what we're talking about nicely here where you have the entire population, the cumulative frequency there.

And then those individual exposed groups, those could be separated by demographics or region, however you want to bin those exposed groups. What you are looking for is the group that would be at the high end of the population, the entire population dose. Also, I've heard it termed in other areas as a sensitive subpopulation.

Advantages, this is consistent with our License Termination Rule. This approach has the 25 millirem per year dose constraint for ALARA for unrestricted release. It is consistent with the new draft ICRP. It was new last year when I wrote this in 2004. The philosophy of focusing radiation protection on the individual.

And then I have to give kudos to the Committee here for your continued concern and actually prompting me to look into this issue. Your continued concerns with collective dose and a number of meetings I had with the Committee last year, there were concerns with continuing use of collective dose.

And a recommendation came out of one of those meetings to use this approach.

EPA uses a similar approach for managing carcinogen risk in a number of their areas, usually unacceptable individual lifetime cancer risk rage of 10 to the minus 4 and 10 to the minus 6. And it can either be morbidity or mortality, depending on what area of regulatory arena you are looking at over there.

Disadvantage, and this is a big disadvantage for how we develop rules and in reg analysis. And using an individual dose emphasis, it

would be very -- well, it is uncertain at this point how you would develop a cost-benefit metric. The 2,000 dollar per person rem value that we use right now is derived from a three million dollar value of a statistical life construct and that is premised on a collective risk, a collective dose value.

So there would need to be some thinking on that how you would actually come up with a value, a dollar value using individual dose emphasis. Again, I don't have that answer right now.

CHAIRMAN RYAN: I know you don't. I just want to make a quick comment. I wouldn't call it a disadvantage. I'd call it the challenge. Because it really isn't a disadvantage. It's just a different kind of construct.

MR. THADANI: But it is a significant challenge because --

CHAIRMAN RYAN: Sure it is.

MR. THADANI: -- if you go back to Genesis, I mean it is all over the map in terms of --

CHAIRMAN RYAN: I understand.

MR. THADANI: -- what estimates you use.

CHAIRMAN RYAN: Absolutely. But it is not necessarily a disadvantage.

DR. BROCK: Okay.

CHAIRMAN RYAN: It might be hard work.

DR. BROCK: Option 4 is a significant determination of a collective dose calculation. Now there are three sub-options to this. There are three approaches that are proposed in the presentation.

So what we do here is we use a Commission-approved criterion to judge the significance of a collective dose calculation. So we're still calculating collective dose but we've calculated collective dose and now we say so what. What does this mean? What does this mean?

The first one is the one millirem per year and 100 person rem per year value that is floating around in international bodies. You're making a judgment there not based on health risk or any of those ideas but mostly that it is not cost beneficial at that low individual and collective dose values, annual dose values.

You see these values talked about throughout the United Nations IAEA, ICRP, and the EU, European Union documents. So in your analysis, if a regulated activity falls below these values, you could exempt it from regulatory oversight.

Advantage, it appears to be gaining some international traction.

Disadvantage, this is small disadvantage but it is theoretical. The nominal 100 person rem per year, you could still exceed that with having some one millirem per year individual doses if you're looking at some practice that involves say the whole country or large, large populations. It's a minor disadvantage.

The second -- or Option 4b for significance determination is compare the collective radiation dose to background radiation for the same population. I think that is an important piece in using collective dose that you have a well-defined population to make a reasonable estimate.

And so if you have whatever number of individuals you have in your collective dose calculation, you use that to calculate the background. This is comparable to what is being done now in NUREG-1515.

Advantage, this is insensitive to the issue of the very small individual doses in a large population resulting in a large collective dose because every individual in the calculation is going to have some background radiation dose to bounce off of whatever dose they get from the regulated activity.

Disadvantage, at this point, it is

uncertain at what fraction or multiple of background collective dose of a regulated activity should staff become concerned. What's the trigger point for us to do further action or no further action?

There might be some insight into the new ICRP recommendations where there are some pieces on couching things in accordance to background. But from what I've read, that's still -- I think there's still some controversy on that from individual doses.

Then the safety goal evaluation, this is the last option. This is expand the use of the reactor safety goal/quantitative health objective value for latent cancer fatalities. This is 0.1 percent of the sum of cancer fatality risks resulting from other causes. And you can apply that to other applications that use collective dose.

Staff would be able to compare collective dose calculations, convert it to a latent cancer fatality risk to this value, and make a determination of not a significant additional risk.

Advantage, safety goals are an NRC constraint albeit this is another path to use them than to how they're used now. Again, similar to the background collective dose calculation, it is insensitive to that issue of very small individual

doses in a large population resulting in a large collective dose because every individual is going to have some background cancer risk.

A disadvantage -- a big disadvantage is that you are pegging this value to a background cancer fatality rate that may fluctuate. Hopefully it goes down over time but by pegging it to a background like that, it can move.

So those are the four options that we've come up with the three sub-options.

The next step, we need to continue discussions with staff at NRC and get more feedback. We also think that there -- possibly hold a workshop to solicit expert elicitation.

And I'd like to acknowledge the following individuals for help on this work, and especially Cheryl for guiding me through this process. And congratulations on your retirement.

(Laughter.)

DR. BROCK: Questions, discussions?

(No reply.)

DR. BROCK: Thank you.

CHAIRMAN RYAN: Thank you, Terry, that was a very well-prepared presentation and laid out all the information well.

Let me offer you a couple of thoughts. And I'm glad you are at this early stage of getting some feedback on all the options without any real slant for one or the other.

When I think about all these options you've presented, I think about them in two ways. One is -- to me, collective dose is a relative metric. That is if I have a set of circumstances that are fairly similar of one case to the other, using it as a metric to say good or bad, kind of the ALARA sort of example you gave, that makes a lot of sense to me particularly in the worker setting because the doses are high enough and they are statistically significant on an individual measurement basis, et cetera, and so on.

So that's a use of it that makes a lot of sense to me. Maybe it is even comparing say fluoroscopic technicians in a hospital setting to others, even though that is not an NRC-regulated activity. Or nuclear medicine techs, or whatever it might be. I can appreciate that.

Where I think your challenge is is that at the, you know, microdoses, megapopulations, or microdoses and small populations. And you mentioned all the problems. For example, individual medical

exposure, which is undocumented for the most part on an individual dose basis. That dwarfs the exposures that you are trying to track and very often dwarfs background. So the largest exposure in that person's history that could result in some endpoint is unknown.

And as you were thinking, I said well how would I attack this problem if I was in Terry's shoes. And I thought about the idea of how about a statistical study? What kind of statistical power would you need to interpret collective dose in any one of your case? What if the profile of a medical exposure looked like this? What if the background exposure looked like this?

And then if the regulated exposure that I'm trying to understand or control looked like this, would you be able to statistically use or not use collective dose in some meaningful way according to one of your options other than the relative measure where all those things might wash out a bit.

Just a thought.

DR. BROCK: Yes.

CHAIRMAN RYAN: My guess is unless you get the doses that are in the range of what the Health Physics Society talked about or others, then you don't have the statistical power to use any of those options

in anything other than a relative way.

So maybe that's something that we could think about offering you a little bit more detailed comment on. And bouncing that off of all the options is to think about would it be statistically powerful enough to even make sense. I mean that test ought to be done up front I think.

What do you think of that? Is this idea making sense? Or am I crazy? Or both?

(Laughter.)

VICE CHAIRMAN CROFF: Yes.

CHAIRMAN RYAN: I just want to thank Dr. Garrick. What do you think?

DR. BROCK: Well, you know, it's -- yes, I think it is probably a good idea to do, to look at. It's hard.

CHAIRMAN RYAN: But even if it was a kind of a theoretical study and you assumed distributions and high doses and average doses and things like that and numbers of people, you can still do a surrogate statistical analysis to see if the power is there to allow you to make hypothesis and conclusions.

And here's where I'm going. If you had a situation A and B and you calculate collective dose 1 and collective dose 2, you might not be able to

statistically see any difference even though the number is different. And until you can demonstrate it is even possible, proposing a metric is a waste of time.

And that's what the constraint of what happens at ten rem and what happens at background and, you know, all those kinds of things that you very carefully outlined as potential challenges or disadvantages or advantages.

So I would suggest that all of those options ought to be tested for their statistical power using this kind of approach. And it can be, I think, done maybe not easily but certainly in a straightforward way.

So I'll just leave you with that thought. And maybe pass the questions on to others. Let's start over here. Bill?

MEMBER HINZE: Well, I was interested in why the NCRP retracted the one millirem individual dose and yet this reoccurs in one of your options.

DR. BROCK: The NCRP originally coined it as a negligible individual risk level. And I think as -- this is back in the 80s -- they came out with -- the individual risk level came out at the time to one millirem per year. And it was really a de minimus

call. But I think as they looked at the collective risk, they realized if we're using LNT, that there really is no theoretical reason, scientific justification to truncate at one millirem per year if we stick to that model.

And I saw that in the literature as I looked through the research for this paper. And that really the arguments seem to fall apart when you are trying to select a value based on a scientific rationale versus maybe some policy decision making.

CHAIRMAN RYAN: I don't think you're right there. I'll tell you why. And a former chairman of this Committee is the one who wrote that into that report, Doctor, Dave Muller. And I know him quite well. And I know he would still support a negligible individual dose.

I think that the scientific validity or not of it being negligible has to be tested statistically. You can't just toss it out or keep it in on the basis of what you think the right answer should be. You can say that the LNT suggests that no dose is without some increment of risk.

But the real question is is that very small dose discernible from any other increment of dose in a meaningful way from a regulatory setting.

So please separate the radiation biology argument from the regulatory argument. They are two very different arguments.

And you can't use the radiation biology argument to support a numerical analysis technique for regulatory decision making. That's the flaw here. And I think that is a very important one to keep separate. That you just really can't use that well, the radiation biology argument is this. Therefore, in the policy area, we must do Y. It doesn't translate.

I think that is a fair criticism of a very often, you know, rigorous battle on LNT and thresholds and all the rest. I mean the fact of the matter is at those very low doses, it is nearly impossible in human populations to resolve the radiation biology question. So you make a policy judgement based on that.

So what we're talking about here is the implementation of a policy analysis tool. Not a radiation biology tool. So criticizing one or two or five or ten or 25 as the right or the wrong number should be a policy question, not something tied to the LNT or the threshold argument. So think I.

MEMBER HINZE: Well, I also wanted to ask what about the measurability of this? You know I get very concerned about how we measure one millirem per

year. Where does that enter into the decision making on this? It's like the groundwater standard: four millirem per year. How do we measure that?

And if we can't measure it, then how can we put it into a collective dose?

DR. BROCK: Yes, it is difficult to measure.

(Laughter.)

MEMBER HINZE: It's a challenge.

DR. BROCK: It's a challenge.

CHAIRMAN RYAN: So, Terry, are you having fun so far?

(Laughter.)

CHAIRMAN RYAN: By the way, we're sympathetic with the strong challenge you've taken on here. So don't -- I mean feel like we're debating with you, not against you.

MEMBER HINZE: Amen to that.

If I could ask you one more question if I might. Mike has very aptly discussed one way of trying to reach a decision on this. If you don't use that approach, how are you going to reach a decision on this? Or how do the policymakers reach a decision on this?

DR. BROCK: I'm not sure what you are

asking.

MEMBER HINZE: Well, you've given us a number of options here. You can approach this from looking at the statistical power of these. And I also think you've got problems in how you make that evaluation of the statistical power.

But the question is if you don't do that, what do you use to make a decision? What kind of -- do you come with your own predilections? Your own prejudices? Your own biases? How does one make a recommendation to the Commission on this?

DR. BROCK: You can see what is done in other arenas. You know in light of the statistical test that Dr. Ryan has talked about, you know there is a large uncertainty there that society still asks us to do something, make a decision. And yes, we have to weigh the statistical power. But often that -- you know, in the light of that uncertainty and ability to make that conclusive argument, we have to make decisions.

We can look for guidance in what other agencies do. The Supreme Court has chimed in on stuff like this. The benzene decision, if you look at that. You have a --

CHAIRMAN RYAN: You mentioned a critical

group. And the average member of the critical group. And things like that. Those are other similar decision making metrics that I think are in place within our own arena. So -- you know, and you can list those in your series of options. So maybe it is something in that category.

DR. BROCK: It is. You know EPA uses that similar approach for regulating carcinogen risk where, you know, if you look, kind of look hard to where their 1E to the minus 6 value comes down from, you know, I've seen different stories on that genesis from detection limits to one in a million seems like a low number to well, to close to the one in the billion brought up in the benzene decision as not a significant risk.

So you're going to have this trans science. At some points, you have to push off of what is socially -- you know there is always a social component to this when you are trying to decide what is safe and ultimately making the decision.

MEMBER HINZE: So are you suggesting that you can come up with criteria on which you can make a decision then? And one of those criteria might be the social acceptability?

DR. BROCK: I think that is the reality of

where we work considering, you know, what we do.

MS. TROTTIER: Can I comment on that? I remind you where EPA got their 10 to the minus 4, 10 to the minus 6 risk range, that's a socially accepted value. They went out and did a poll on what was socially acceptable. I mean this is a policy thing.

And I think what we're trying to accomplish here is to explore not only the options that our cumulative brains put together in this paper but to see, you know, A, where there are holes, B, where there might be other options.

Even though, unfortunately, I'm the ultimate short-timer here, I mean my eventual goal is that we get something in front of the Commission. But what we get in front of them needs to be the best possible set of options for them to make a reasoned decision.

So, you know, just having your feedback is really helpful because, you know, this is like a first step. We haven't even actually flowed this in front of offices other than a couple. So, you know, we really want to get other offices within the agency to look at it and get some other opinions.

CHAIRMAN RYAN: Allen?

VICE CHAIRMAN CROFF: Yes, I may be less

of an expert than some of these wizards in this area, but I wanted to understand your suggestion better. As I understood what you said, it was -- I would call it a detectability-based approach. In other words, if based on all the population of the U.S., you couldn't see a particular collective dose, then it would be okay.

CHAIRMAN RYAN: Well, not exactly. I guess the statistical power question is if you could construct two data sets, one with one exposure and one with another collective exposure, do you have statistical power to say they are different? In other words, my hypothesis is these are different. And you go through the statistical analysis based on what you know about your data. And you say yes, I can or no, I can't at some confidence level. Real basic stuff.

My feeling is that is going to be real difficult in most every case. So the metric falls down as a metric.

On the other hand, if you took the remi or, you know, some aspect of a subset of a huge population that was at some higher risk within the population, as we do now, and kind of focused it up in that way, that might be a path forward to help overcome that.

Now I'm not saying do one or the other. What I am saying is for the options that you've laid out, and maybe with a more focused emphasis on the option for a remi, that you design a thought experiment that will allow you to do the statistical power assessment of all these options.

Some of them may rise up as the best options from a statistical power point of view. And some may fall off the table. But I think that's one step towards, you know, when you go forward to the Commission with here are the options for using collective dose and here's why I think they have merit, they're going to say well what about this microdose to megapeople? And say well, here is the statistical power analysis.

It says this one hold up and this one doesn't. Between this range of dose collectively and this range of individual highs and lows and zeros and all of that, given that you understand background and medical exposure and over the ranges which they range.

I mean that's what I would try and do first just to see whether these constructs that you've created hold up or hold water. Because at the end of the day, if it is not used in this relative way that we've talked about, for example ALARA Option 1 and

ALARA Option 2 and the lower dose wins, you know, in a worker setting, it's a very good metric for those purposes, clearly and now it's used routinely, but for the bigger, you know smaller doses to larger groups, it needs to be tested. So that's what I was trying to get at.

The other problem of measuring the dose and knowing that in a given population your dose is 1.2 and mine is 1.3, that's a whole different measurement issue. And needs to also be factored into the precision with which an individual's dose is known, which is probably more like 25 percent at best at those levels.

The other issue we haven't touched on is protracting the dose. In many of these accident scenarios, it is internal exposure as well as some external component.

So you not only have dose delivered over some event, you have a big fraction of the dose potentially delivered over decades. So what does that mean now when we've got, you know, a changing risk as a function of A? So it can be challenging.

Yes?

MR. THADANI: But, Mike, there is another element which might be equally important and that is

you use some analytical tools to calculate these things. And particularly if you are in the reactor world, you're talking about accidents and you are trying to calculate what happens at some distance.

To what extent tools such as MAX -- and perhaps Cheryl can address this issue -- have been validated? There might be some significant uncertainties over there that somehow have to be accounted for because this is one element of the bigger picture.

CHAIRMAN RYAN: So you are saying it makes it worse rather than better?

MR. THADANI: No, I'm not saying it's worse. No. I'm saying that you need to look at -- take an integrated look at the pieces.

CHAIRMAN RYAN: Absolutely.

MR. THADANI: And not just pick one.

CHAIRMAN RYAN: All the pieces in a given scenario have to be evaluated.

MR. THADANI: With these options, for each of the options, you do have to step back and say what else do we need to fulfill that specific option?

CHAIRMAN RYAN: Absolutely.

MR. THADANI: And how well can we really do that?

CHAIRMAN RYAN: And, again, my A and B scenarios are just simple-minded starters to just do the statistics. But then you do have to fault any uncertainties of all the other aspects.

MR. THADANI: I agree.

VICE CHAIRMAN CROFF: I think I understand what you were talking about now, which wasn't quite what I was thinking so thanks for that.

CHAIRMAN RYAN: Okay.

VICE CHAIRMAN CROFF: I think my observation is I'm not right now seeing a way to get at this issue without just having to make a policy decision. Basically as the NCRP said, as a practical matter for regulatory purposes, we're going to go with something here. And that bullet is going to have to be bit, if you will.

CHAIRMAN RYAN: And given that, that's where I get to the suggestion about doing a statistical power analysis to help rank them in a way where decision making can be best informed.

Ruth?

MEMBER WEINER: Thanks.

First of all, I wanted to thank you for having the slides available beforehand because I had a chance to go through this. And that was wonderful.

I am clearly not an expert in this area. But I do use the concept of collective dose in a manner that was blessed by NRC more than 30 years ago in NUREG-0170. And I've always wondered about its validity, by the way.

I'd like to focus on Option 4, which strikes me as being important in communicating any of these concepts. What is the significance of the dose?

And I have a couple of questions I'd like to ask you. Option 4b, which is a very attractive option, compares background collective radiation dose. And you say as a disadvantage or in the current words, a challenge, it is uncertain at what fraction or multiple background of collective dose should staff become concerned.

Don't you have to make that decision all the time anyway? I mean is this -- is deciding at what number you start to take some action, isn't that something that NRC does anyway in all kinds of contexts?

DR. BROCK: From my review -- maybe if there is someone else in the audience that's more of an expert on where this came from -- NUREG-1515 -- what I read was there was just a comparison to what the expected background radiation dose. It wasn't --

there was an implicit judgment in there that that was okay.

So what I'm saying here is what is the explicit A Priority decision-making tool beforehand? What are we saying beforehand is of concern to staff? What would trigger staff when they saw that whatever emissions were coming out of a facility or whatever this regulated activity was contributing, what kind of dose they were contributing in comparison to this background, that's really the essence of that option.

MEMBER WEINER: Well, that's really -- you've touched on the essence of my question. And I think stated it better than I can. As a regulator, NRC is always making decisions about what is a significant impact. And in comparison to something else. Not in this particular case you haven't made the decision. But --

CHAIRMAN RYAN: Well, Ruth, I don't know. I challenge you on that because every standard that I know of excludes backgrounds. Five rems per year to workers doesn't say anything about background.

MEMBER WEINER: No --

CHAIRMAN RYAN: -- millirem --

MEMBER WEINER: -- I understand.

CHAIRMAN RYAN: -- to the individual and

no relationship to background.

MEMBER WEINER: No, I understand that.

CHAIRMAN RYAN: This is a metric and a standard review point. That's much different than a dose estimate -- I mean a dose standard.

MEMBER WEINER: Yes, that's really the essence of my question. Since you make decisions about standards, okay, any kind of standard, I don't see that a mechanism for making this kind of decision is out of the question. That's all I was trying to say. It's not that big a disadvantage because you surely --

CHAIRMAN RYAN: So comparison to a background dose in Denver versus the Jersey shore results in two different decisions maybe.

MEMBER WEINER: Besides, implicitly we make these decisions anyway.

CHAIRMAN RYAN: Just a thought.

MEMBER WEINER: My other question has to do with the safety goal evaluation which it is really a comment, which again, I think is an interesting -- it is a very interesting concept.

And clearly, you know, you have pegged something that the background cancer fatality rate fluctuates not only time but over space, over all

kinds of things. Would years of life lost to cancer be a better metric? Is it one you have considered?

DR. BROCK: Well, there are plenty of metrics you could use. You know economists do that all the time. There is quality-adjusted life years, years of lost life. Quite frankly, I was looking for something that the Commission had spoken to in 1E to the minus 4 and the E minus 6 --

MEMBER WEINER: Range.

DR. BROCK: -- world.

MEMBER WEINER: Yes.

DR. BROCK: And this caught my eye. The Commission had made, you know, a statement like this that we could work off of. So yes, you could use other outcomes. You know you could use morbidity. You could use total detriment.

MEMBER WEINER: Yes.

DR. BROCK: In fact, I believe the 2,000 dollars per person rem is based on the total detriment risk coefficient, not just mortality. So, yes, yes you could.

MEMBER WEINER: My final question is we use, in transportation, risk assessments. We use collective dose, of course. And for routine transportation, you say you integrate over the

population in a half mile band on either side of the highway.

DR. BROCK: Right. A half way around the --

MEMBER WEINER: A half mile around whatever. To get away from this microdoses -- or at least to modify the microdose to megapeople concept, what would be your reaction if we simply used, as a comparison metric, the dose to the -- the largest dose of that band, the dose to the people nearest to the source rather than integrating over a megapopulation?

DR. BROCK: Oh, boy. I don't know if I have an answer to you.

MEMBER WEINER: This is not a trick question.

DR. BROCK: I'd have to look at that for a while.

MEMBER WEINER: Let me know what you think of it.

DR. BROCK: Sure.

MEMBER WEINER: I don't need an answer right away.

DR. BROCK: I can get back to you. I'd have to look at that and think about that for a while. There are a couple of factors going through my head

right now about where exactly you would -- well, population is going to be very important and where, if you postulate an accident, where exactly that accident occurs. So that would have to play into it.

So I'm going to punt on that one right now, if you don't mind.

MEMBER WEINER: No, that's fine. Just let me know any thoughts you have.

DR. BROCK: Okay.

CHAIRMAN RYAN: Jim?

MEMBER WEINER: That's it.

MEMBER CLARKE: I think both of you have touched upon an area that I was going to ask a few questions about. And that's non-radionuclides, chemicals that cause cancer or are believed to cause cancer where we use a linear no-threshold model as well.

You spoke to the EPA range. They like 10 to the minus 6 a lot and 10 to the minus 4 less. And kind of negotiate in that range if we looked at an example. I think they try to set drinking water standards towards the low end. But sometimes you can't do that and arsenic is a good example where you just can't reliably measure it at the 10 to the minus 6 level. It is closer to the 10 to the minus 4.

Does the EPA have anything analogous to collective dose if you had a large population that has low levels of a chemical carcinogen?

DR. BROCK: I can speak to this.

MEMBER CLARKE: Is that an area -- it sounds like you are pursuing it. I just wanted to --

DR. BROCK: You don't -- you know EPA has a number of areas they regulate with different statutes that drive how they regulate areas. The Safe Drinking Water Act, I believe there's even a cost-benefit provision in Safe Drinking Water.

MEMBER CLARKE: There is.

DR. BROCK: In the Federal Insecticide, Fungicide, and Rodenticide Act, when they regulate pesticides, there is an explicit no cost-benefit analysis. It's health-based only.

As far as collective risk, if we focus in on clean up of say the Super Fund world, they've really moved away from that. I think the last time I saw anything of collective risk was late '80s, early '90s.

MEMBER CLARKE: It's individual risk.

DR. BROCK: Yes, it's individual. The reason we maximum expose an individual where they'll pick the 95th percentile of a distribution up until --

and pesticides when they do an A Priority risk management decision, they can go up to 99.9 percentile of the distribution. Then again you're talking about food that we all eat. So it's, you know, of 300 million people, you know the 99.9 percentile of the population is what they are regulating at.

So no, you don't see collective risk used. They can. I mean they could. But they've decided not to use that risk management approach.

MEMBER CLARKE: My overly simplistic initial reaction, not working in this area, was you know what questions couldn't you answer if you didn't have anything like a collective dose. And so now I have to ask what questions can't the EPA answer if they don't go this way.

DR. BROCK: I would say there would be --

MEMBER CLARKE: You know I see the utility as ranking.

DR. BROCK: Well, we're dealing with different paradigms. We deal in the radiation protection paradigm with limits and justification and optimization that collective dose lends itself pretty well to in doing cost-benefit analysis.

In EPA space, you're talking about the health risk paradigm where there is not necessarily a

cost-benefit consideration. And they don't have to do -- not in all cases where they don't have to do the collective type --

MEMBER CLARKE: It would seem like there would be a cost benefit --

DR. BROCK: In some cases, there are, and in some cases, there aren't.

MEMBER CLARKE: -- population exposed to a low level of a carcinogen.

DR. BROCK: Again, I go back to the pesticide world. There is an explicit piece in that that it is health based. It's not, you know, it's Congress that made the decision. Society made the decision that they're not going to do a cost-benefit analysis on that.

But going back to your original question, the collective risk value is -- I haven't seen it used in a long time.

CHAIRMAN RYAN: Jim, I think on the EPA side, to me it's always interesting. When the EPA gets done with whatever assessment they're going to do to decide on the right answer for an environmental hazard or a food hazard or whatever it might be, they end up with a concentration. It can't be any more than this. And that can be easily measured with high

precision.

So all the policy and technical decision making is wrapped up into that one statute whereas -- and I think this is the difference in the two paradigms. Terry, tell me if you agree, where we have an individual dose for workers. We have an individual dose for members of the public.

And we're constantly revisiting the dose, the calculation of dose, the measurement of dose, and making a policy decision based on that, folding in that we have ALARA, which says let's be lower than the dose as possible.

So we have kind of a more dynamic judgment of success against the dose standards than perhaps you might on the EPA side. I mean the chemical side, my concentration is one-tenth of the limit. I'm done.

Well, that may or may not be the answer on the radiological side given that you've got ALARA and other concerns and issues.

So it is a different circumstance. I agree with Terry's comment. But for more of that kind of thinking.

MEMBER CLARKE: Yes, it still strikes me that there are some striking similarities.

CHAIRMAN RYAN: Oh, there are as well.

Yes, there are as well. But I think the fact that we are regulating, you know, the result of the use of a concentration in material and EPA just stops with regulating the concentration is a big difference ultimately.

DR. GARRICK: Yes. What I hope happens, and I don't know where this thing is going, is that it doesn't preclude common sense from being a part of the process. For the most part, I think that collective dose is a bad metric for most risk work. Particularly if you are trying to nail down individual risk, I think it is a very bad metric.

But I can see a lot of applications even that we're engaged in now where it can be very valuable. For example, one of the big debates in the Yucca Mountain project is the worker risk with respect to the surface facilities. And I can see collective dose as being a very useful tool to do comparative studies.

But I think the Committee is already on record of not being very supportive of using collective dose as a risk metric in general. So common sense, I hope, is allowed to enter into the process.

Part of the problem with a lot of the

regulations is that it puts a constraint on that. And I just hope that that doesn't happen this time. Thank you.

CHAIRMAN RYAN: Any questions or comments? Latif?

MR. HAMDAN: Terry, I think this question would be enhanced if you had a fifth option here, the option of doing nothing. You touch -- in the background, you talk about why you are doing this. But I think it is a question of advantages and disadvantages. Doing nothing would be the case either way.

CHAIRMAN RYAN: Thanks, Latif.

MR. THADANI: Just a small suggestion for you to think about. In your paper, you have an example, smoke detectors, I think, example. I thought that was done very well.

But under the option of using Commission safety goals, I mean there is a lot of background there but nevertheless, you allocated the whole goal of the smoke detectors in your estimates that you had.

You might want to think about as, you know,

you were talking about pros and cons, one con certainly would be how do you suballocate the

Commission's goal. If you choose that option, how would you suballocate to different contributors that impact public health?

CHAIRMAN RYAN: Okay. Thanks, Ashok.

Again, Terry, you have taken on an interesting and challenging problem. And we appreciate your thoughtful comments and suggestions. And whenever we get this kind of dialogue going, I always feel like we've got a good step towards maybe offering some advice in a letter that would be helpful and gives you things to think about.

I think we'll probably end up trying to write down some of these suggestions and options in a letter to you to give you some food for thought.

And I'm particularly interested on maybe the statistical approach to help rank options as a way to sort them out a bit and see where we might go from there.

And then also emphasize this idea that in certain circumstances as a relative measure, it has obvious use and merit today. But as an absolute measure, there are some challenges ahead.

And, again, I think the difference between a biological argument and a policy argument really need to be clarified because we can't let that

slippage between the two occur because it is often part of the ongoing battle on rad say, for example, that just doesn't help anybody to come to better thinking about it.

But, again, thank you both for being with us. And once again, Cheryl, congratulations --

MS. TROTTIER: Thank you.

CHAIRMAN RYAN: -- on your retirement. Actually, I'll look forward to seeing you. Come back and visit anytime.

MS. TROTTIER: I'll sit in the audience next time.

(Laughter.)

MS. TROTTIER: No, I want to thank you because this has been very helpful for me. I assume for Terry as well. Our goal is to get more feedback as we move forward with this paper. So it was very, very beneficial. Thank you.

CHAIRMAN RYAN: One other thing we didn't touch on but I think the idea of an expert elicitation is a good one.

And we'll probably suggest that because I think more of these kind of working debates -- and we might even expand your list a bit and talk about epidemiologists and statisticians and others that can

help you evaluate some of these questions and maybe come up with evaluation protocols and help in that area. So we might expand upon that a bit, too.

DR. BROCK: Okay. Thank you.

CHAIRMAN RYAN: All right. Great. Thanks for being with us.

Okay, we're scheduled for letter writing. Why don't we just take a quick ten-minute break and start right at 2:15. Thank you.

That will conclude our record for the day. I think we're done with presentations. And the rest on the letter writing, we won't need a transcript. So thank you very much. We'll conclude the record.

(Whereupon, the above-entitled meeting was concluded at 2:06 p.m.)

CERTIFICATE

This is to certify that the attached proceedings before the United States Nuclear Regulatory Commission in the matter of:

Name of Proceeding: Advisory Committee on Nuclear Waste
161st Meeting

Docket Number: n/a

Location: Rockville, MD

were held as herein appears, and that this is the original transcript thereof for the file of the United States Nuclear Regulatory Commission taken by me and, thereafter reduced to typewriting by me or under the direction of the court reporting company, and that the transcript is a true and accurate record of the foregoing proceedings.

William Click
Official Reporter
Neal R. Gross & Co., Inc.

Development of International Standards on Geological Disposal

Tim McCartin
U.S. Nuclear Regulatory Commission
Presented at:
International Conference on Geological Repositories
Stockholm, December 8-10, 2003

Outline

- Background
- Safety Fundamentals
- Safety Objectives for Geological Disposal
- Safety Requirements for Geological Disposal

2

Background

- IAEA's Radioactive Waste Safety Standards Program
  - principles and requirements
  - guidelines for implementation
- Internationally agreed Safety Standards
  - provide point of reference for national criteria, standards and practices

3

IAEA Safety Fundamentals

- Sets principles that apply to all radioactive waste management activities
- Objective of waste management:
  - protect human health and environment now and in future
  - not impose undue burdens on future generations

4

IAEA Safety Requirements for Geological Disposal

- Objectives for protection of human health and environment including quantitative criteria
- Strategy for achieving safety
- Development, operation and closure

5

Safety Objectives During Operations

- Limits on radiation doses to workers and public
  - worker (50 mSv in any one year and 20 mSv per year averaged over 5 years)
  - public (average doses to relevant critical groups of 1 mSv per year)
- As low as reasonably achievable, social and economic factors being taken into account

6

Safety Objectives
Post Closure

- Limits on radiation dose or risk to public
  - 1 mSv per year from all sources
  - 0.3 mSv per year from disposal facility (risk constraint on the order of 10^{-5} per year)
- Caution on applying criteria at long time periods in the future

7

Requirements for Safety Strategy

- Legal and organizational framework
  - responsibilities of government, regulator and operator
- Safety approach
  - development process
  - passive safety
  - adequate understanding and confidence)
- safety design principles
  - multiple safety functions
  - containment
  - isolation

8

Requirements for Development of Geological Disposal Facilities

- Framework for geological disposal
  - step-by-step development and evaluation
  - preparation of safety case and safety assessments
  - scope of safety case and safety assessments
  - documentation of safety case and safety assessments

9

Requirements for Development of Geological Disposal Facilities (cont.)

- Steps in development of geological disposal facilities
  - site characterization
  - design
  - construction
  - operation
  - closure

10

Requirements for Development of Geological Disposal Facilities (cont.)

- Assurance of safety and security
  - waste acceptance
  - monitoring
  - Post closure institutional controls
  - safeguards
  - quality assurance

11

Summary

- IAEA is developing a set of safety requirements for geological disposal for:
  - planning
  - designing
  - operating
  - closure
- Safety strategy is important for ensuring that at each step in the development an adequate understanding and confidence in safety is developed

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Overview of Research in Support of Decommissioning Program

Presentation to:
The Advisory Committee on Nuclear Waste
July 20, 2005
William R. Ott, Section Chief
Office of Nuclear Regulatory Research
301-415-6210 WRO1@NRC.GOV

Briefing Outline

- Background - Commonality of Issues
- Structure of the Program / Major Topical Areas
- Discussion of Topical Areas - Recent Products, Current Activities, Future Focus
- Cooperation with NMSS and Other Federal Agencies
- Proposed Interactions with the ACNW

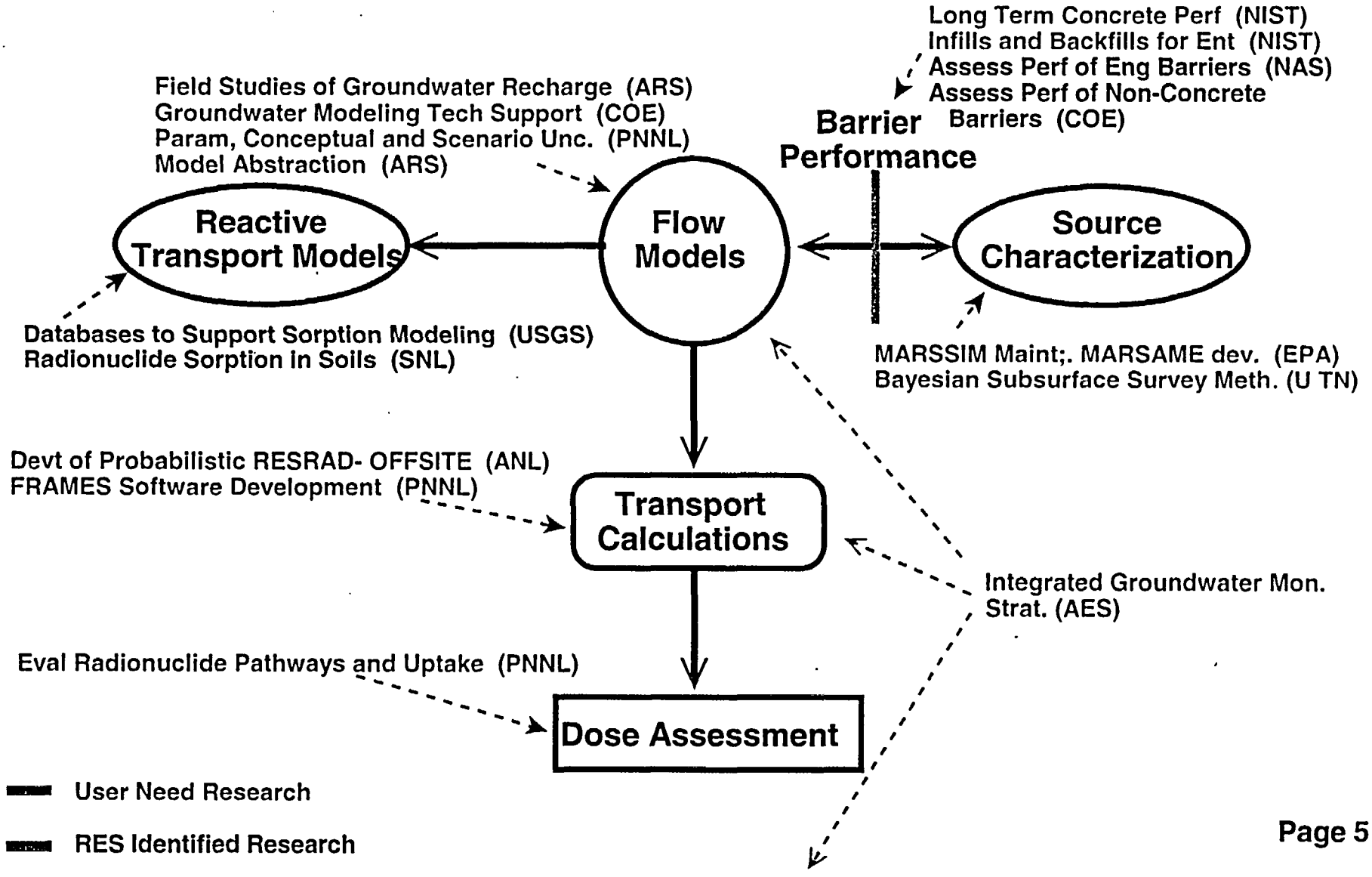
Background

- Began with generic environmental transport issues being addressed in the HLW and LLW research programs, i.e. non-specific to repository or LLW user needs
  - Includes general topics such as infiltration, flow, sorption, uncertainty, etc.
  - Excludes such topics as volcanism, corrosion, elevated temperature geochemistry, i.e. those topics which apply only to HLW
- Many issues overlap and are relevant to HLW and LLW as well as decommissioning
  - coordinate with NMSS staff in Decom, FC, HLW, LLW;
  - inform them of progress;
  - involve them in activities such as MOU working groups, workshops, and the NEA Sorption Project

Background (cont'd)

- Focus is:
  - Largely on the near surface - supporting realistic assessments of potential exposure of the public from decommissioning and remediation actions (e.g. in situ leach uranium mines)
  - On sites where relatively simple tools and techniques can not address existing conditions -e.g., temporal and spatial variability in chemical or hydrologic conditions, distributed source terms
  - Covers the full range of PA
- Primarily user need generated topics

Radionuclide Transport Research in Support of Decommissioning - Major Topical Areas



Components of Research

- **SOURCE CHARACTERIZATION -** Developing methods for more efficient and effective surveys to accurately assess contamination.
- **BARRIER PERFORMANCE -** Evaluating the effectiveness over time of engineered barriers to movement of water and contaminants.
- **FLOW MODELS -** Improving models to address more complex groundwater systems and the latest advances in treating subjects like conceptual model uncertainty and model abstraction.
- **REACTIVE TRANSPORT MODELS -** Developing models of contaminant migration that are sensitive to environmental conditions such as Eh and pH.

Components of Research (cont'd)

- **TRANSPORT CALCULATIONS -** RESRAD-OFFSITE is being developed to handle simple sites with offsite effects; FRAMES is being developed as a flexible platform for building site specific models of complex sites that incorporate all significant features and processes.
- **DOSE ASSESSMENT -** Staff is currently assessing the status of data used in pathway models and collecting new data to fill significant gaps.
- **MONITORING -** A methodology is being developed to integrate information on site characterization, performance assessment, and instrumentation to design efficient long-term monitoring programs.

Source Characterization

- Extensive prior work on LLW characterization and activated metals at PNNL and INL, slags at PNNL and JHU
- MARSSIM Maintenance, MARSAME development
  - Cooperative interagency effort
- Bayesian Subsurface Survey Methods (surf, material, vol)
  - Development of Spatial Analysis and Decision Assistance software (SADA) (started by the DOE) & Field Environmental Decision Support (FIELDS)
  - Most currently accepted statistical analysis methods available to the user
  - Current release SADA version 4.1
    - User Guide completed 4/05
    - Training provided March 2005

Source Characterization (cont'd)

- Developmental tasks in follow-on project
  - Incorporate soft information including uncertainty directly into estimation using Markov Bayes II techniques
  - Direct interface with and incorporation of geotechnical data
  - 3D variogram maps
  - Bore hole location & sampling design optimization
  - Estimation of likelihood of miss
  - Simplified implementation guidance (yes/no roadmap)
- Work carried out in cooperation with the Environmental Protection Agency (original sponsor of FIELDS)
- Briefed ACNW 2003 as part of support for rulemaking on Control of Solid Materials. Tentative proposal for detailed briefing Fall, 2005.

Barrier Performance

- NIST - Work initiated to resolve issues related to long term performance of concrete barriers, use of barriers at contaminated facilities, and to support emtombment
  - Developed 4SIGHT - first code for assessing long term degradation of concrete properties - current applications may include WIR, concrete covers, concrete vaults, leakage from spent fuel pools
  - Work on cement based infills/backfills is relevant to WIR
  - Research concludes mid 2006 (Research Information Letter)

Barrier Performance (cont'd)

- COE/WES - Research on long term performance of clay based soil covers
  - Recent briefing of staff by COE and their principal sub-contractor, Professor Craig Benson, University of Wisconsin, February, 2005
  - Failure of clay covers may be a result of dessication after installation wet of optimum
- Upcoming activity - National Academies Committee on Asessment of the Performance of Engineered Barriers
  - Workshop planned for August, 2005, Washington, DC
- ACNW - Supported IDIP and WIR workshops
  - Briefing in spring, 2006, on results of concrete work on strucures and infills and backfills (research information letter planned for March, 2006)

Flow Models

- Completed extensive research on flow in unsaturated, fractured rock (U of Az (Evans, Neuman & Bassett)) and unsaturated soils (NMSU, and U of Az(Wierenga), PNNL (Gee & Meyer), MIT (Gelhar & McLaughlin)).
- Current research focused on treatment of uncertainty and model abstraction.
  - PNNL developing an integrated approach to uncertainty to include parameter uncertainty (PNNL), conceptual model uncertainty (U of Az), and scenario uncertainty. Includes application to existing field data.
  - ARS working cooperatively on Model Abstraction.
  - Other work at ARS has focused on more realistic estimation of recharge and has incorporated hands-on participation by RES staff.

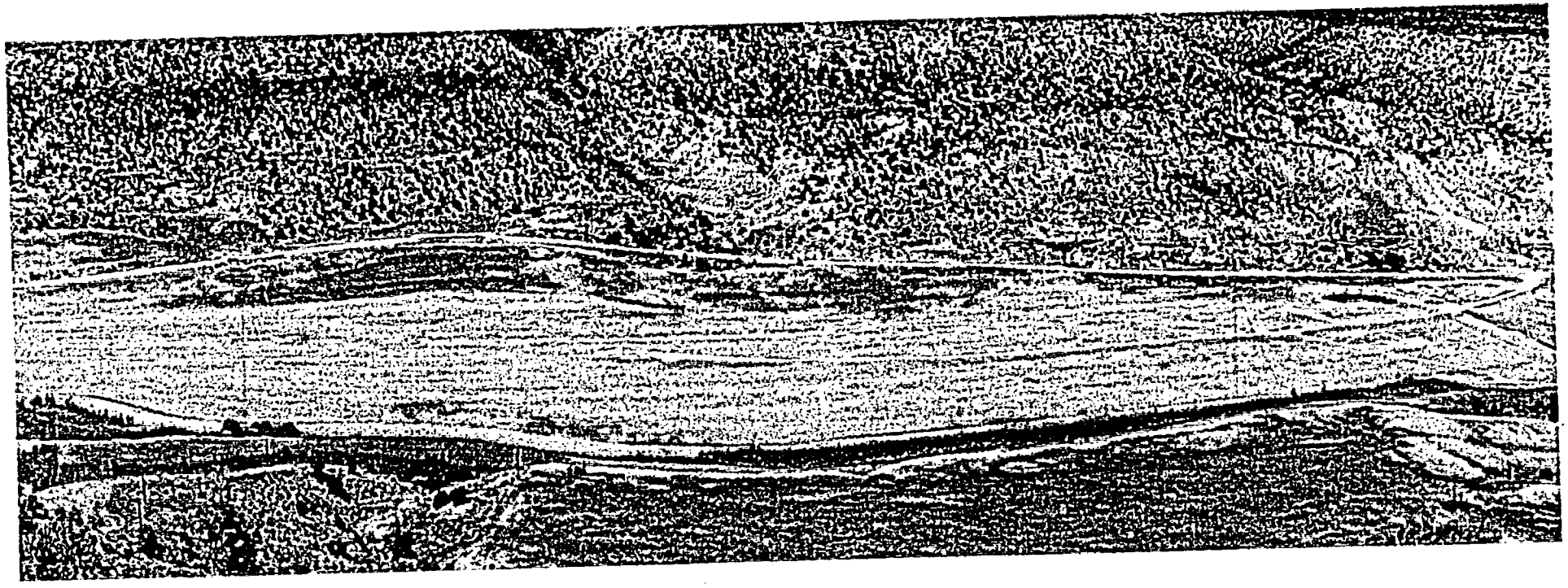
Flow Models (cont'd)

- Corps of Engineers providing support through access, modification, and training on GMS (Groundwater Modeling System -sophisticated 1, 2, 3D flow and transport) as a stand alone and linked to FRAMES
- Tentative follow-on areas
  - Comparison of simple to complex flow models using ARS watershed database
  - Couple integrated uncertainty methodology to monitoring
- Interactions with ACNW
  - Recent briefings by ARS (2005) and PNNL (2004)
  - Additional briefings not planned at present time.

Reactive Transport Models

- Initial work in HLW and LLW focused on use of traditional distribution coefficient - acknowledged from the beginning that the approach was a computational convenience
  - HLW focused on elevated temperatures
  - First HLW and then LLW work turned to sorption mechanisms and understanding chemistry - goal: realistic reactive transport models
  - Work conducted at PNNL and CNWRA and later USGS (Alligator Rivers)
- Decommissioning program
  - Work continued at Alligator Rivers, Naturita and Cape Cod, with fundamental modeling work conducted at SNL
  - Helped organize and implement OECD/NEA Sorption Project, Phases 1 & 2 - publication of Phase 2 report imminent - comparison of particpants' modeling approaches against standard test cases
  - Initiated MOU Working Group 3 on Reactive Transport

Naturita Field Site



Reactive Transport Models (cont'd)

- Current status
  - USGS demonstrated utility of Generalized Composite (GC) approach to sorption modeling for uranium at Naturita - new work extending to other radionuclides and other conditions
  - SNL encoding GC and component additivity (CA) approaches using USGS RATEQ for inclusion in FRAMES -should be complete by this fall
  - Participants in NEA Sorption Project will meet in October to consider development of a Phase 3
  - MOU Working Group 3 held international workshop in April, 2004 - proceedings at www.ISCMEM.ORG
- Future focus is on data to populate models
- ACNW interaction - would like to bring in SNL and USGS this Fall to discuss their work, MOU workshop, and NEA Sorption Project.

Transport Calculations

- The vehicles for transport calculations are the integrated models that manage the source term, infiltration, flow and transport calculations to produce concentrations at some point of exposure as input to a dose model
- Work initiated with SNL HLW work and migrated to CNWRA
- Performance Assessment Working Group (PAWG) applied experience from HLW to LLW and produced NUREG-1573 which advocates probabilistic techniques - used for DandD (SNL) and RESRAD (ANL)
- Current focus is on RESRAD-OFFSITE for routine cases and FRAMES as a platform to build complex site models
  - RESRAD-OFFSITE beta version and manual released for testing in October, 2004
  - FRAMES2 with MEPAS, GENII,and 3MRA modules and linkage to GMS released March, 2005

Transport Calculations (cont'd)

- Future products
  - Modification of RESRAD-OFFSITE to enable wider range of site-specific exposure scenarios
  - More realistic treatment of reactive transport and improved linkage to GMS in FRAMES
  - More realistic values for fish consumption pathway for all models
- Training for both RESRAD-OFFSITE and FRAMES2 are planned in FY 2006
- ACNW interaction - briefing on FRAMES2 in Winter, 2006

Dose Assessment

- NRC has not focused on changes or improvements to dose models until initiation of the biosphere pathway study
- Initiated project with PNNL to examine assumptions supporting data in food chain pathway analyses and identify any areas where new data might be necessary
  - Project was discussed with ACNW in February, 2004
  - Radionuclides being addressed were modified as a result of ACNW recommendations (Ni dropped, Am added)
- Current focus
  - Soil and water samples from three different sites and soil types for study of ^{99}Tc in crops including onions, corn, potatoes, and alfalfa
  - Collaboration with OSU for uptake studies in fruit and nuts (apple, pistachio, apricot, pecan, pomegranate, grapes, carob)

Dose Assessment (cont'd)

- Current focus (cont'd)
  - Participation in IAEA program to update plant and animal transfer factors (IAEA TRS-364)
- Upcoming activities
  - Extend plant studies to include Am and Np
  - Considering proposals for animal studies in Russia (Mayak) and Kazakhstan (Semipalatansk NTC)
  - NUREG/CR report on soil and water analyses and agricultural data expected in August, 2005
- ACNW - Further briefings not planned at this time

Monitoring

- Monitoring has not generally been required for decommissioned sites that satisfy the requirements for unrestricted release according to the License Termination Rule
- In cases where unrestricted release is not possible, monitoring to assure compliance may be necessary
- Project was initiated through the RFP process to develop an integrated approach to ground-water monitoring (Advanced Environmental Systems (AES) selected)
  - Incorporates information from site characterization, performance assessment, site design
  - Includes concept of performance indicators (measurable parameters that can be linked to features or models) that may mirror or anticipate site failure and test PA
  - Acknowledges that early detection is more effective than after failure

Monitoring (cont'd)

- Developed methodology for design of monitoring program
- Current focus is on applying methodology to existing data sets
- Future activities include
  - Couple integrated uncertainty methodology to monitoring
- ACNW - Plan to brief on monitoring in Fall, 2006

Cooperation with NMSS and Others

- NMSS
  - Technical Advisory Group (TAG) on Assessing Uncertainty
  - TAG on Groundwater and Performance Monitoring
  - Technical assistance as requested and as available on specific activities (IDIP, WIR, West Valley, Shieldallloy)
  - Quarterly meetings with Environmental Protection and Performance Assessment Directorate in Division of Waste Management and Environmental Protection
- Other Federal Agencies
  - MOU on R & D of Multimedia Environmental Models - working groups on Software, Uncertainty, and Reactive Transport - www.ISCMEM.org
  - Cooperative funding of NAS projects such as "Assessing the Performance of Surface and Subsurface Engineered Barriers" with EPA and DOE

Cooperation with NMSS and Others (cont'd)

- Other Federal Agencies (cont'd)
  - Agencies with significant interactions include: EPA, USA COE, USGS, ARS, DOE
- International Participation
  - OECD/NEA-IGSC (Integration Group for the Safety Case)
  - IAEA-ASAM (Application of Safety Assessment Methodologies) - Working Group on the "Role of Conservatism versus Realism"
  - IAEA-EMRAS (Environmental Modeling for Radiation Safety)
  - OECD/NEA Sorption Project Phase 2 (twelve countries)

Proposed Interactions with the ACNW

- Fall, 2005 - Detailed briefing on Reactive Transport research
  - USGS work on Generalized Composite Model
  - SNL work on sorption mechanisms and modifications to FRAMES to allow more realistic treatment of sorption
  - Results of MOU workshop on reactive transport
  - Results of OECD/NEA Sorption Project, Phase 2
- Fall, 2005 - Briefing on SADA 4.1
- Winter, 2006 - Briefing on FRAMES2
- Spring, 2006 - Briefing on results of concrete work on structures and infills and backfills (research information letter planned for March, 2006)
- Fall, 2006 - Briefing on results of integrated monitoring project

Discussions on Collective Dose

ACNW Brief
July 20, 2005

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Purpose

- To provide information and to facilitate discussion on potential options for using collective dose more effectively and realistically

Background

- The NRC uses collective dose in decision-making in a number of regulatory activities, including value-impact analysis (VIA; also known as cost-benefit analysis or benefit-cost analysis) to support the Regulatory Analysis process in the development of new regulations

- In some cases, the individual doses calculated are very small, while the number of potentially exposed individuals is quite large. In such cases the collective dose can be quite large

- NRC bases its estimates of radiation risk on the linear no-threshold (LNT) dose response hypothesis, this means that any potential dose, no matter how small, is taken into account in the collective dose calculation and ultimately in the value-impact analysis

Collective Dose: $S = \sum H_i P_i$

- where S refers to the collective dose to the population at risk, and H_i is the per capita dose in subgroup i, and P_i is a subgroup i of Population P. (ICRP 26, NCRP 121)
- the sum of the individual doses received on a given period of time by a specified population from exposure to a specified source of radiation. (NRC Glossary)
- Corollary to the Linear-No-Threshold dose response model when used to calculate health risk

Collective dose uses at NRC

- Retrospective Domain
  - Collective dose is usually calculated from individual measured dose (e.g., dosimetry records)
  - The population is usually well defined in time and space.
  - Examples
    - REIRS D-base
    - Nuclear Power ALARA performance indicator
- Prospective Domain*
  - Event or Doses have not occurred yet.
  - The population at risk is not always spatially or temporally well defined.
  - Examples
    - Used in Reactor Level 3 PRA Consequence Analysis
    - Planning (Safety and Security)
    - Regulatory Analysis / Value – Impact Analysis

*Focus of this paper

Option 1 – Truncate individual doses at some nominal value

- Truncate individual doses at some nominal value from the collective dose calculation
- Truncate individual doses at some distance from a facility or at some future time
- NCRP at one time recommended that individual doses at 1 mrem per year could be excluded from collective dose calculations, but later retracted that recommendation (NCRP 1987, NCRP 1993)
- NCRP, along with ICRP, now explicitly states that there are no theoretical reasons to exclude any individual doses, no matter how small, from a collective dose calculation, but there may be practical reasons to do so (NCRP 1995, ICRP 1997)

Option 1 – Truncate individual doses at some nominal value

Advantages

- Truncating at some nominal dose value would address the concern of large collective doses from many small individual doses over very large populations

- NRC already spatially truncates collective dose calculations used to demonstrate that the reactor safety goal is met and for environmental assessments at 1, 10, and 50 miles, respectively, setting a precedent that truncation is acceptable in this context (NRC 1986, NRC 1999)

Option 1 – Truncate individual doses at some nominal value

Disadvantages

- The individual dose value to truncate from the collective dose calculation is strictly a policy decision and it could be difficult to justify the value selected because there is currently no theoretical reason to truncate individual doses from a collective dose calculation

- The role of ALARA may need to be addressed in some individual dose values selected for truncation from the collective dose calculation

Option 2 – Health Physics Society position on collective dose

- For populations in which **almost** all individuals are estimated to receive a lifetime dose of less than 10 rem above background, collective dose is a highly speculative and uncertain measure of risk and should not be used for the purpose of estimating population health risks.- *Radiation Risk in Perspective, 1996, reaffirmed in 2004*
- Estimation of health risk associated with radiation doses that are of similar magnitude as those received from natural sources should be strictly qualitative and encompass a range of hypothetical health outcomes, including the possibility of no adverse health effects at such low levels

Option 2 – Health Physics Society position on collective dose

Advantages

- The health risks implied by a collective dose calculation would be less uncertain if almost all of the individual doses were not less than 10 rem lifetime

- Would address the concern of over-aggregating many small individual doses over very large populations to estimate health risks, since all individuals in the population should not have doses less than 10 rem lifetime

Option 2 – Health Physics Society position on collective dose

Disadvantages

- The HPS position of 10 rem lifetime above background is from all sources of exposure, not just Atomic Energy Act material. The problem with this from an NRC perspective is that it does not take medical exposures into account to make the lifetime dose determination
- An approach to use qualitative descriptors of risk would be difficult to develop and use. The possibility of using qualitative descriptors of risk in cost-benefit analysis would need to be explored

Option 3 – Individual dose emphasis

- Emphasizes protection of individuals in the critical group of an exposed population and assumes that if the average individual in the critical group is protected, the entire population is protected
- No collective dose is calculated in this option

Option 3: Individual Dose Avg. Individual of the Critical Group

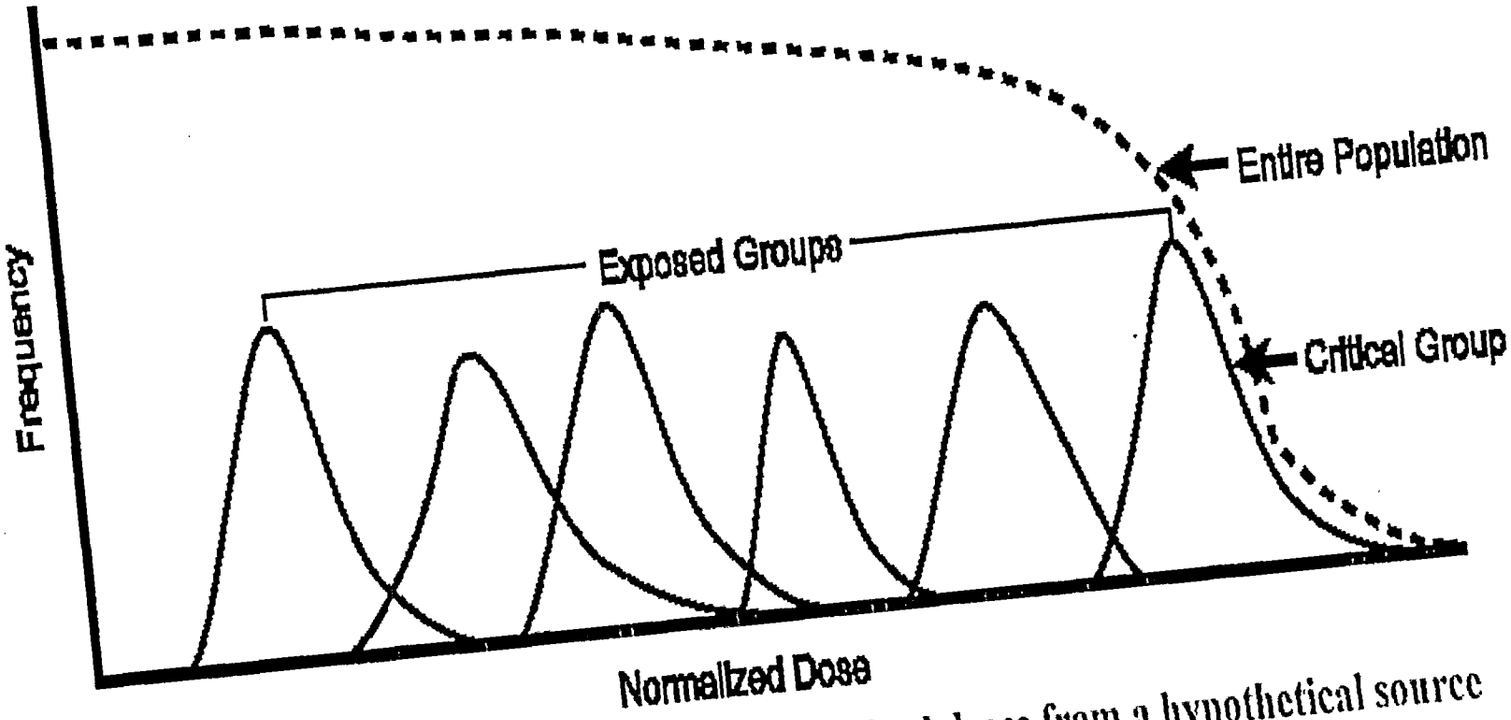

Figure 1.1 Frequency distributions of normalized doses from a hypothetical source

Ref: NUREG-1640

Option 3 – Individual dose emphasis

Advantages

- Consistent with the10 CFR Part 20 Subpart E, "Radiological Criteria for License Termination Rule," which explicitly states that the average individual of the critical group must be below a 25 mrem per year dose constraint plus ALARA

- Consistent with the new draft ICRP 2005 philosophy of focusing radiation protection on the individual

- The ACNW in a 2004 meeting expressed concern with staff's continued use of collective dose and suggested an approach similar to this option. ACNW recommended that the staff use this option instead of collective dose when individual doses are small and aggregated over a large populations and for scenarios with small, long-term releases

Option 3 – Individual dose emphasis

Advantages cont.

- EPA uses a similar approach for managing carcinogen risk, usually at an acceptable individual lifetime cancer risk range of 10^{-4} to 10^{-6}.

Disadvantage

- An approach would need to be developed to do a cost-benefit analysis with individual dose values alone. Cost-benefit analyses are performed from a population or collective point of view, and typically do not address the distribution of costs and benefits to individuals in the population. The $2,000 per person-rem value used by NRC is a population-based monetary metric that does not consider the distribution and any equity issues of the individual doses in the population

Option 4 – Significance determination of a collective dose calculation

- Use a Commission approved criterion to judge the significance of a collective dose calculation

Option 4a: 1 mrem per year and 100 person-rem per year

- International bodies argue that it is not cost-beneficial to do a formal CBA process when individual and collective doses are less than 1 mrem per year and 100 person-rem per year, respectively and the practice can be exempted from regulatory oversight (IAEA1996, ICRP 1992, EC 1999)

Option 4a: 1 mrem per year and 100 person-rem per year

Advantage

- Appears to be gaining international acceptance and is recommended by IAEA and ICRP as criteria for exempting a practice from regulatory consideration

Disadvantage

- The nominal 100 person-rem per year does not address the concern of many small doses aggregated over very large populations

Option 4b: Background collective radiation dose comparison

- Compare the collective dose from a regulated activity to the collective dose from background radiation to the same population
- This approach is comparable to the approach in NUREG-1515, "Standard Review Plans for Environmental Reviews for Nuclear Power Plants"

Option 4b: Background collective radiation dose comparison

Advantage

- Insensitive to the issue of very small individual doses in a large population resulting in a large collective dose. Every individual in the collective dose calculation, regardless of individual dose, has a background radiation dose that is aggregated for comparison to the collective dose calculation for a regulated activity

Disadvantage

- It is uncertain at what fraction or multiple of background collective dose of a regulated activity should staff become concerned

Option 4c: Safety goal evaluation

- Expand the use of the reactor safety goal / quantitative health objective value for latent cancer fatalities of "0.1% of the sum of cancer fatality risks resulting from all other causes" to other applications that use collective dose
- Staff would compare collective dose calculations to this safety goal value, either in units of person-rem or latent cancer fatality (LCF) risk, and make a determination of "not a significant additional risk"

Option 4c: Safety goal evaluation

Advantage

- Safety goals are an NRC construct and already a component of regulatory analysis for power reactors
- This approach is insensitive to the issue of very small individual doses in a large population resulting in a large collective dose. Every individual in the collective dose calculation, regardless of individual dose, has a background cancer risk that is aggregated for comparison to the collective risk for a regulated activity

Option 4c: Safety goal evaluation

Disadvantage

- The background cancer fatality rate may fluctuate over time.

Next Step

- Continue discussions with staff
- Possibly hold a workshop to solicit expert elicitation

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Questions / Discussion