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NUCLEAR REGULATORY COMMISSION

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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

(ACRS)

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SUBCOMMITTEE ON RADIATION PROTECTION

AND NUCLEAR MATERIALS

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TUESDAY

OCTOBER 4, 2011

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ROCKVILLE, MARYLAND

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The Subcommittee met, at the Nuclear Regulatory Commission, Two White Flint North, Room T2B1, 11545 Rockville Pike, at 8:30 a.m., Michael Ryan, Chairman, presiding.

SUBCOMMITTEE MEMBERS PRESENT:

MICHAEL T. RYAN, Chairman

SAID ABDEL-KHALIK

DENNIS C. BLEY *

J. SAM ARMIJO

JOHN D. SIEBER

CONSULTANTS TO THE SUBCOMMITTEE PRESENT:

JOHN FLACK

NRC STAFF PRESENT:

DEREK WIDMAYER, Designated Federal Official

MAURICE HEATH

CHRISTIANNE RIDGE

DREW PERSINKO

ALSO PRESENT:

JOHN COCHRAN

CLINT MILLER *

* Present via telephone

C-O-N-T-E-N-T-S

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

1:58 p.m.

CHAIR RYAN: (presiding) The meeting will now come to order, please.

This is a meeting of the Radiation Protection Nuclear Materials Subcommittee. Today we are gathered to hear a review of the Branch Technical Position on Concentration Averaging and Encapsulation.

Maurice, are you going to lead us off?

MR. HEATH: Yes, I will.

CHAIR RYAN: All right. Thanks. Maybe you could introduce the speakers today and cover a little bit of an intro. That would be helpful.

MR. HEATH: Okay. Thank you.

First, I would like to thank you for giving us the opportunity to bring you a brief today on the revisions to the Draft Branch Technical Position on Concentration Averaging and Encapsulation.

Today myself will be giving the introduction. Then I will turn it over to Dr. Christianne Ridge. She will be going over the homogeneity guidance. And Mr. John Cochran from Sandia National Lab, who has been working with us in this effort, he will go over the other technical points in the presentation.

CHAIR RYAN: Thank you.

MR. HEATH: Now before we get started, we can kind of put things in context. We believe that the draft that we are going to present to you is significantly improved from the 1995 version. We believe that it is going to help potentially improve the waste management and disposal practices. It implements the Commission's direction to risk-inform/performance-base the agency's blending position. It provides for disposal rather than indefinite storage of additional sealed sources that currently are classified A, B, and C, which could be prohibited by disposal facility licenses that reference the existing BTP.

And also, we believe it is better organized and it is more transparent in the technical bases that have been developed. It will help stakeholders to understand the position and provide more meaningful comments as we go through this effort to revise the BTP.

So far, we have had some feedback from the draft BTP. A number of stakeholders have said it is more clear, that it is a better read. We have also got some feedback from DOE, the NNSA, the National Nuclear Security Agency, who manages thousands of commercially-sealed sources which have been collected from licensees. And they have strongly supported the changes and believe that some of the changes with the sealed-source position will help alleviate some of the stranded sources that are out there today.

CHAIR RYAN: Have you received written communication about those views?

MR. HEATH: No, we haven't. We are not going to put the draft out for formal public comment until after the ACRS full Committee, and we need to write the letter after the full Committee meeting.

CHAIR RYAN: Okay.

MR. HEATH: Then we want to put the document out for our formal comment period. So, so far, these are comments that they have told us from being at conferences and that sort of thing, that they have said, given us those feedbacks.

CHAIR RYAN: You might take a note, John, to consider inviting DOE to the full Committee meeting to hear their views directly --

CONSULTANT FLACK: Yes. Yes.

CHAIR RYAN: -- if they manage a large number of these sealed sources.

Thank you.

MR. HEATH: Now, as we just stated, we

will be back in December for the full Committee. At that time, we hope to have more comments from stakeholders and the public. Because on October 20th, we will have a public meeting out in Albuquerque, New Mexico.

At that meeting, we will be discussing the draft BTP and there will be various stakeholders. We have Agreement State regulators that have said they will be attending. So, we hope to get more feedback. So, in December, we will be able to come back and give you more feedback on what we have heard so far, these changes.

CHAIR RYAN: Maurice, I guess at this point -- correct me if I am wrong -- it is my understanding that the NRC will not directly regulate anything that is covered by this BTP; that right now at least the situation is that only Agreement States will be the responsible regulatory authority for licensees under this guidance. Is that correct?

MR. HEATH: That is correct. And this is guidance. And we make that a point, that this is guidance for the Agreement States. They will be the ones that are enacting that with their licensees, yes.

CHAIR RYAN: Thank you.

MR. HEATH: Now one thing before I get

into the presentation. I want to stress that we are still in the process, obviously, of revising. So, we are open to take comments of any type. We really want to hear the comments that you have for us today.

CHAIR RYAN: Okay.

MR. HEATH: So, that is going forward.

All right.

CHAIR RYAN: I think you have control of the -- (referring to the visual presentation).

MR. HEATH: Okay.

CHAIR RYAN: Okay. Yes. Okay. Great.

MR. HEATH: I will do a brief introduction, kind of what the BTP is. Then, I will do a little kind of a background. And then, the last thing, I want to make the distinction between the site-specific analysis and the BTP because we understand that there has been --

CHAIR RYAN: You might just want to move off that a little bit. There you go.

MR. HEATH: We understand that you had quite a few presentations on the site-specific analysis. We just want to make sure that we draw the difference between the two.

And the next slide, like I said, Dr. Ridge will be covering/demonstrating homogeneity and classifying homogeneous waste, and John Cochran will be covering the classifying of mix, make sure of individual items, encapsulation of sealed sources, and our alternative approaches.

What is the BTP? The BTP is the guidance document for waste generators and processors that help in classifying waste for disposal under Part 61. And it also provides a method for averaging and classifying radionuclide concentrations in waste over a volume or mass of waste package. And one note that we want to make is an important aspect is the BTP is widely used in the industry from power plants to other generators and processors and, also, like we said earlier, Agreement State regulators as well.

Now Part 61, in Subpart C are contained like four performance objectives. Now any disposal facility has to follow these four performance objectives and they have to be met when disposing of low-level waste.

Now how that applies to BTP today is that BTP, the basis of the averaging provision of BTP is to protect the inadvertent intrusion, which is contained in 61.42. Now the way to accomplish that protection from an inadvertent intrusion is with the waste classification in 61.55. That's the Tables 1 and 2.

That defines the class of waste, either A, B, or C.

And in the regulation, the provision that actually states in the regulation for averaging is 61.55(a)(8), which allows for concentration averaging in determining waste class.

Now the last bullet is 10 CFR Part 20, Appendix G. And what this regulation is, it is really the uniform manifest, the manifest that accompanies the waste. The main thing that it gives on this manifest, when you are ready to ship your waste, the manifest gives you container description and identify of the waste. It also has a classification that you make when you are shipping for disposal.

This is Table 2 that is out of the regulations. What I just want to emphasize on this slide is just that, when we are talking for the table and the concentrations, we are talking curies per cubic meter. That is the one thing. And the BTP tells how to average the waste classification, so that you can meet the 61.55 table, as you see above, and to protect the inadvertent intruder.

CHAIR RYAN: What radionuclides are in play after, say, a 300-year life for a low-level waste site for an institutional control period?

MR. COCHRAN: Some that might surprise you with a moderate half-life of cesium and strontium are still there. Your transuranics are going to be there. For example, niobium-94 is going to be there.

CHAIR RYAN: Yes, 300 years strontium and cesium are pretty well done.

MR. COCHRAN: Unless they begin as a concentrated sealed source. We will talk about that in a second.

CHAIR RYAN: Okay. I will be curious to hear what you have to say about it. I get uranium, a little bit of some of the longer-lived irradiated hardware metals, but I come up with five radionuclides that might be around after 300 years. I'll share that with you when you get to your list.

MR. COCHRAN: Okay.

MR. HEATH: All right. Now I am going to just give you a little brief background on kind of how we got to this point today. Back in 2007, the staff performed a strategic assessment on NRC's low-level waste program. Out of that assessment, we identified revising the BTP has a high priority. And also, in that assessment we said that we would risk-inform/performance-base the positions contained in that BTP.

Now, a little later, blending of low-level waste was on the table, and it became a topic. And so, we developed a SECY paper, a blending SECY paper, that was sent to the Commission. Now, during this effort, the BTP was put on hold until we could work out the issue of blending.

Now the SRM from the Commission on blending came down, and the Commission agreed with Option 2 in that blending paper, which said that we would risk-inform the blending position in the BTP. The staff also thought that we would risk-inform/performance-base the entire BTP as well, as we identified in our strategy assessment in 2007.

This slide is just to show the definition of risk-informed/performance-based, and this was a definition that came out of NRC's strategic plan, NUREG-1614.

This next slide is just to show how it relates to the BTP. When we say "risk-informed", we are talking guidance linked to limiting doses to inadvertent intruder. We are talking reasonably foreseeable scenarios and evaluated consequences to the intruder.

And when we say "performance-based", we have two major things we are talking about, measurable parameters, concentrations of radionuclides, and we are talking about an additional thing that we provide, which is additional flexibility. That is in our alternative approaches section in the BTP.

CONSULTANT FLACK: Can I ask a question on that, Mike?

CHAIR RYAN: Please do.

CONSULTANT FLACK: Yes, on the inadvertent intruder, when you say you use risk-informed, do you try to quantify the probability of the intruder entering into the vicinity? I mean, how do you do that?

MS. RIDGE: No, we haven't done that.

CONSULTANT FLACK: So, it is not risk-informed? That part is not risk-informed?

MEMBER ARMIJO: That is strictly deterministic, right? Somebody decides there will be an intruder?

MR. COCHRAN: It is not a probabilistic risk assessment, but rather risk-informed.

CHAIR RYAN: So, what does it mean if it is not probabilistic? How is it risk-informed? What is your metric to risk in that setting?

MR. COCHRAN: The regulation requires us to protect the intruder.

CHAIR RYAN: The inadvertent intruder?

MR. COCHRAN: The inadvertent intruder. Thanks for the clarification because the regulation requires us to protect the inadvertent human intruder.

And in the development of Part 61, the NRC used reasonably foreseeable, yet conservative exposure scenarios, set limits on the concentrations of radionuclides that could be disposed of in the near surface. Okay? So, they used reasonably foreseeable, circumstances that we all believe might occur.

CHAIR RYAN: I wouldn't say "we all".

(Laughter.)

Some might.

MR. COCHRAN: But some might.

CHAIR RYAN: That is the whole point, though. There is no way to come to agreement analytically on one view versus another view in terms of its being risk-informed. That's the problem.

MR. COCHRAN: That's true. But science, I mean, others have wrestled with this in high-level waste, spent fuel. There is no scientific way to determine the probability of some future exposure scenario.

MEMBER ARMIJO: That is why it is pretty subjective.

MR. COCHRAN: And so, that's why it is subjective.

MEMBER ARMIJO: Right.

MR. COCHRAN: And that's why the regulatory authority needs to set the basis. If you leave it to the Agreement States and the licensees, the licensees' view of the future is there won't be any intrusion. Stakeholders may say there could be terribly extensive intrusions. Somebody could build a school here, for example. And there is no way to resolve between the two perspectives.

The NRC chose 25 years ago, and we followed in their footsteps, to set reasonably foreseeable, yet conservative, exposure scenarios to then determine what is safe in your service disposal.

CHAIR RYAN: And how to interpret those concepts are all in the eye of the beholder. There is nothing analytic about it, in my view.

MR. COCHRAN: I hope that at a high level that concept is fairly agreeable. We should select reasonably foreseeable, yet conservative scenarios. The details are absolutely in the eye of the beholder.

CHAIR RYAN: So, the concept is also in the eye of the beholder and what they mold out of it?

MR. COCHRAN: The fine line is in the eye of the beholder. We hope that the concept is agreeable, that the regulation says we need to protect the intruder. The NRC chose 25 years ago that we were going to use reasonably foreseeable, yet conservative, exposure scenarios.

CHAIR RYAN: Well, I would have to say that I hear the words, but they all sound horribly qualitative -- and I mean "horribly" in the way you would think. It is not tenable to have something that is not commonly interpretable by all that use it. And my experience is it has been very widely interpreted for a long time.

MEMBER ARMIJO: Yes, and for what period of time? We get into that issue of how far into the future do you have to protect these intruders. We got into that a couple of meetings ago.

CHAIR RYAN: Even a simpler question of, when does an inadvertent intruder become an advertent intruder?

MS. RIDGE: If we could just return to the original question for just a moment, though, I am not sure -- and if I could amplify what John said -- I am not sure I would say it is fair to say it is not risk-informed at all. Because whenever you make a choice about what scenarios to consider, and I agree with you it's subjective, and that possibly could be improved, although I think that would be an extremely difficult technical problem when you start looking into the future.

But I don't think it is fair to say it is not risk-informed, because whenever you choose a scenario, you are making a risk decision. You are saying, for example, if the waste is buried in the first few meters, we consider that someone could put a dwelling on the site. If it is deeper than that, we are making a decision that we are not considering that scenario. That is not quantitative, but that is risk-informed.

Someone could come and build a very deep basement for a very large structure, and we are making a risk decision that we think that that is sufficiently improbable, although we haven't been able to quantify it, that we are not considering that.

So, I would agree with you that work could be done to improve the quantification, but I don't think I would agree that we can say that these aren't risk-informed at all. Because whenever you choose a scenario, you are implicitly making a risk decision.

CHAIR RYAN: In a qualitative way. That's the point, is that it is not quantifiable; it is qualitative. And that is where I think it falls a little short, but I think we understand.

MEMBER ARMIJO: Yes, but the dilemma starts with the regulation, which says protect inadvertent intruder for any and all. I think those words are in there, which is literally something that you can't do really. So, you are making some judgments on how to limit that.

And our problem is, you know, judgment is being used. Our definition of risk is different than -- we use it with a capital "R"; at least that is what the PRA guys do. So, these are judgments that are made and, to a certain extent, are deterministic. People can discuss it forever and still not agree.

But the inadvertent intruder issue drives the answer. It seems to me that these conclusions and everything is driven by that issue of protecting this inadvertent intruder. And that is the problem, where the real thing is to protect people, in your term, who are working at the site.

So, I have a philosophical problem with protecting somebody thousands of years in the future compared to people who are here today.

MR. COCHRAN: If you look at the development of the Part 61 regulation and, in particular, limiting the concentration of the nuclides in the near surface, in that development they divided the waste into Class A, Class B, and Class C.

And the assumption was that Class A waste would be waste that we would only need to isolate from the inadvertent human intruder for 100 years, and the standards would be pretty easy to implement.

B waste, they limited the concentrations such that at 300 years you could have the inadvertent human intrusion, as envisioned in the draft and Final EIS, and the intruder would be protected at 300.

Class C, the intruder is protected to 500 years.

And then greater than Class C, typically is inappropriate for near surface. And the intruder would not be protected, even if they inadvertently entered the landfill at year 501.

So, there may be some mixing of the site-specific assessment rulemaking with the tables that are in Part 61.

MEMBER ARMIJO: Okay, there probably is. There probably is some confusion.

MR. COCHRAN: Those tables that are in 61 that set the Class A, the Class B, and the Class C limits, those are all set up. In Class A, the curie limits are pretty low, and that waste will be safe for inadvertent human intrusion, as described through the draft and Final EIS, the rulemaking process, safe at 100 years; B at 300; C at 500.

CHAIR RYAN: That's the part I don't understand. How can something be safe at 100 years, something else doesn't become safe for 300 years, and it is all buried the same way and we are talking about the same level of intrusion? Intrusion is binary. It either happens or it doesn't.

Let me get back to my point earlier.

MR. COCHRAN: It's the concentrations that provide the safety.

CHAIR RYAN: Ah, so, I mean, we have got 3,000, I'm sorry, 5,247 curies of uranium-238. That is what is in one disposal site right now. It is obviously not decayed.

Carbon-14, 3,380 or so curies. I-129, 9 curies. Tech-99, 117 curies. You know, they have kind of taken cesium and strontium off the list because they are 10 times the half-life and essentially gone.

So, I don't understand what we are protecting the inadvertent intruder from. By the way, the uranium, the carbon, the iodine, and technetium are very well-distributed in lots of different waste. Yet, they are still classified based on their quantity.

MR. COCHRAN: It is the specific activity that is really --

CHAIR RYAN: Of the radionuclide itself, not necessarily in the waste form, right?

MR. COCHRAN: Of the waste form that the intruder sees. They don't see the entire inventory in a landfill.

CHAIR RYAN: Right. But, I mean, the point is that this is distributed over millions of cubic feet of material. I am still struggling with it, and honestly so. I am not trying to be critical of what you are talking about, but there is very little activity left after 300 years, and we are putting a huge burden on inadvertent intrusion control and response. So, I just offer you that thought to think about when you make your comments.

MR. COCHRAN: I certainly appreciate your concerns. And hopefully, as we talk through some of the exposure scenarios, and we have more meaningful discussion, there is quite a bit of material yet to cover.

CHAIR RYAN: Okay. Fire away.

MR. HEATH: All right. This slide just represents the major changes, a comparison to show, it gives you what was in the 1995 BTP and what was revised. We are going to cover all of these in our presentation. Like I said earlier, Dr. Ridge will cover the homogeneity, the removal of the factor-of-10 constraint for blending of waste, and then John will take care of the technical issues with the sealed source, for instance, the factor of two. And we will get into that during the presentation.

The last thing I want to go over is just to make the distinction, because we have already had some talk about the difference between site-specific analysis rulemaking and the BTP. Now they both deal with intruder protection, but the primary user for the site-specific analysis is the disposal facility, and the primary user for the BTP are the generators and the processors.

And one of the other major distinctions is the site-specific analysis rulemaking, the purpose if regulation, so adding an additional measure, where the BTP is just guidance that is not a requirement.

CHAIR RYAN: How do you think they will match up or become aligned? I mean, the bottom line is a site-specific rulemaking, it is a regulation. It is going to end up with a license that has license requirements that most likely are going to require the BTP to be used. So, it, in effect, carries the weight of regulation. I don't see the distinction in splitting the two apart and saying one is guidance and one is regulation.

MS. RIDGE: Well, I think the BTP is fairly clear in providing alternatives that John will discuss in more detail. But it explains, tries to explain fairly clearly, this is one way of showing that you have concentration-averaged appropriately. There are other considerations, and it describes other considerations.

CHAIR RYAN: It wouldn't surprise me to see a license condition at a new site that says, "Thou shalt follow the BTP," period.

MS. RIDGE: But if it does, the BTP itself provides for alternative consideration.

CHAIR RYAN: In this way. I mean it will be very specific, I would guess. I think whatever variability exists in the BTP will be taken out by licensing. That's my guess.

MR. COCHRAN: Well, to amplify what Christianne just said, the new BTP -- and I'll talk about this -- the alternative approaches really give both the Agreement States and the licensees a lot of room for using site-specific factors to deviate from the guidance. You are not deviating from the regulation at this point. You are just deviating from the guidance. And the BTP, this revised BTP tries to make it a lot easier to do that.

CHAIR RYAN: Okay.

MR. COCHRAN: So, that is fairly different than having something in some of the regulation and wanting to deviate from the regulation.

CHAIR RYAN: Uh-hum.

MR. HEATH: Now, also, when we have our public meeting and the state regulators are there, we are hoping that we get comments like that from the state regulators. And then, if we do, we will definitely bring that back in time to the full Committee.

CHAIR RYAN: Thank you.

MR. HEATH: Okay. Now I will turn it over to Dr. Ridge for the homogeneity guidance.

MS. RIDGE: Well, thank you again for your time. And I just wanted to reiterate we are looking forward to your comments on this draft guidance.

Next slide.

This is a slide that, actually, the next slide is a slide you have seen before. This slide just describes the waste types that are addressed in the BTP. I am only going to talk about one of them. I am only talking about homogeneous waste. John is going to talk about the remaining waste types.

CHAIR RYAN: Okay.

MS. RIDGE: Before we go on, I do want to make a couple of general points about homogeneous materials. These are wastes that I am sure you are mostly familiar with, but like ion-exchange resins, soils, ash, among other things, that are flowable, miscible, and, in part, for that reason, are assumed to be well-mixed, if an intruder were to encounter these wastes.

There are other wastes, for instance, solidified liquid, maybe not as miscible when an intruder brings them up, but uniform when disposed. And so, that is also regarded as a homogeneous waste.

Containerized dry active waste also regarded as a homogeneous waste, not so much because it is homogeneous when it is disposed, but because after 100 years it is assumed to degrade to a point that it will be miscible if intruded upon. So, these are items, generally, that we are assuming, if someone were to exhume, they would be mixed during that process. And those are things we are regarding as homogeneous wastes.

Most low-level waste by volume is homogeneous waste. And homogeneous waste is the waste that is easiest to apply concentration averaging to. Essentially, you can divide the curies in the container by the volume or the mass, whichever is appropriate according to the tables, and that is the end of the process and you have a number. You do not need to apply any of the additional constraints that are recommended in the guidance for these other waste types. So, there is an interest in demonstrating that a waste is homogeneous because it does affect how complex the concentration averaging is.

Next slide.

This slide you have seen before. Maurice presented this. These are the topics we are going to address today, and I just wanted to point out I'm only going to be talking about the first, demonstrating homogeneity and classifying homogeneous waste.

CHAIR RYAN: You are missing all the fun on 2 and 3 and 4.

(Laughter.)

MEMBER ARMIJO: Well, I just want to ask a question.

MS. RIDGE: Sure.

MEMBER ARMIJO: Are there types of waste that someone might consider as homogeneous that others would say, "Oh, no, that can't be homogeneous."? It is in these issues, areas where people have big disagreements and --

MS. RIDGE: That is a very good question.

MEMBER ARMIJO: It always happens. You know, you think you have made a clear definition, and there is always this middle transition zone where it might be or might not be.

MS. RIDGE: Absolutely. And the guidance I think tries to address that.

MEMBER ARMIJO: Okay.

MS. RIDGE: The first subtopic I am going to talk about within the homogeneity guidance is homogeneous waste types. And this is extremely similar to what is in the 1995 BTP.

Essentially, in the 1995 BTP there are certain waste types that are designated as being homogeneous. And with a very small change, we kept that from the 1995 BTP, and those waste types are listed.

Those waste types specifically, and I mentioned some of them earlier, are assumed to be homogeneous, and we are not proposing to apply any test to show that those waste types are homogeneous. I mentioned earlier ion-exchange resins --

MEMBER ARMIJO: Soils.

MS. RIDGE: -- ash, soils, dry active waste in containers, solidified liquids, absorbed liquids. And these waste types are, as I said, assumed to be homogeneous. And I am going to talk about that in a little more detail, but we are not changing the 1995 guidance on these topics.

CHAIR RYAN: Just one other, is there a placeholder for a new waste form that could be homogeneous based on these criteria? I am thinking of reverse osmosis waste, for example, you know, that has no residence. It is just an RO-type process. So, there are some processes out there where you get a homogeneous waste that is not on that list. How are you going to deal with that.

MS. RIDGE: Right. That is a very good point. And we would certainly consider putting a placeholder to make other waste streams designated.

The next part of the guidance on my next bullet addresses one specific waste type and a recommended approach for demonstrating that that waste type is homogeneous.

And so, there is a process that we will talk about --

CHAIR RYAN: Okay.

MS. RIDGE: -- for showing that other waste types are homogeneous. That is not precisely the same thing as saying, forevermore, this waste type will be designated as one of the designated homogeneous waste types. And that is certainly something we could consider. But the guidance does address looking at a specific waste and showing whether or not you would consider it homogeneous.

CHAIR RYAN: Okay.

MS. RIDGE: And the next thing I will touch on briefly is classifying these homogeneous wastes.

Now the reason we developed those homogeneity guidance, there are four primary reasons. One is that the 1995 BTP included what was known as a factor-of-10 constraint on inputs to a waste mixture. And what that said was that you can mix these flowable waste types and classify based on the mixture if the inputs will be within a factor of 10 of what the average will be after you mix them.

So, you have the average after you mix them, and the ingredients to that mixture have to be within a factor of 10. Essentially, it prevented mixing things across classes because you couldn't mix things that had concentrations that were too different.

Now this is not a very performance-based way to look at things because you are looking at the inputs to a process rather than the output. And so, one of the changes in the proposed draft BTP is that it eliminates this factor-of-10 constraint on inputs to a waste mixture, and instead, looks only at the end of the process and not the inputs to a process.

Now eliminating that constraint does introduce a small concern for the safety of the inadvertent intruder. And I am going to talk about that in more detail on my next slide.

But, essentially, if you are not limiting the inputs, you have no more control over what is in that container unless you look at the outputs. And that is what we want to do with the homogeneity guidance.

Now the next reason for introducing this homogeneity guidance is a stakeholder concern. And I know that you are all familiar with the blending issue, of an industry proposal to blend wastes that have concentrations that would be greater than Class

A concentrations with waste that has concentrations that would be lower than Class A concentrations, to in the end come up with a Class A mixture.

And if in the end that waste has concentrations that meet the tables, that is a Class A waste. But there is a stakeholder concern, knowing that more concentrated wastes have gone in, and not knowing how well those wastes are blended. And so, the BTP proposes criteria for looking at the output of that process that would show that the waste is essentially sufficiently blended, and that you do have Class A waste and not --

CHAIR RYAN: We are kind of touching on an area where I think it is real important to understand there are two different kinds of intrusion into the waste. And the part you are talking about now to me is the fractional release from the inventory to a vector that can expose humans.

So, let's say it contaminates groundwater, just as an example. It is not the inventory that matters, unless you drill through it. I would argue that --

MS. RIDGE: Drilling through it is specifically one of the concerns.

CHAIR RYAN: But let's just leave that one just aside for a minute.

MS. RIDGE: Sure.

CHAIR RYAN: A fractional release from the inventory to environmental media is really a little bit different than how is it mixed, because the inventory is what drives the fractional release. If I have one curie of cobalt in a concentrated source, that is a lot different than if I have 100 curies of cobalt on an ion-exchange resin or 1 curie of cobalt on an ion-exchange resin.

So, I am trying to just think about those kinds of variables as well. So, maybe you can touch on, you know, when I have concentrated materials versus non-concentrated. I am not in favor of the factor-of-10 rule, but it is not the inventories so much in the subsets, components of a waste mix that trouble me. It is the fractional release from the entire inventory that really sort of sets the stage for an impact analysis for me.

MS. RIDGE: And I would agree, the fractional release from the inventory is, I want to say critical, but it is more than critical. It is the whole story for someone who is offsite. And for someone who is offsite, you are looking at the fractional release from the inventory.

For someone who is onsite and intruding into the waste, then concentration can matter.

The third point --

CHAIR RYAN: With direct exposure, but not with putting a well down.

MS. RIDGE: Right. Right. I would agree with you on that.

CHAIR RYAN: Only when you dig it up and get next to it, whatever that means.

MS. RIDGE: Precisely. Precisely.

CHAIR RYAN: Okay.

MS. RIDGE: The next reason for creating some homogeneity guidance is to be consistent with an increased emphasis on site-specific scenarios that we have talked about a little bit with the site-specific analysis, which is a separate but related effort.

And finally, the staff was directed by the Commission to create some guidance around waste homogeneity, and specifically directed to consider waste homogeneity in the context of intrusion scenarios. And that was in the SRM we received in response to the paper on blending.

CONSULTANT FLACK: So, if I could just ask a question on that, the blending is actually to reduce the risk to an inadvertent intruder? Is that what is happening here? I mean, is that why you would want to blend, so that you don't have an inadvertent intruder hit one of these concentrated areas. So, it is more like a defense-in-depth than it is a risk. I mean, you are applying some form of defense-in-depth against that scenario, right?

MS. RIDGE: If we don't drop the factor-of-10 constraint that is in the 1995 BTP, you can't blend waste.

CONSULTANT FLACK: Okay. That's a process.

MS. RIDGE: Right.

CONSULTANT FLACK: But the reason for doing it, other than the process piece --

MS. RIDGE: The reason for doing it is to define a disposal pathway for B&C waste.

CONSULTANT FLACK: So, it is the process that is driving it? You have to get rid of the waste somehow, right? So, it is not the risk at all.

CHAIR RYAN: John, let me try an approach. I think, to me -- and correct me I am wrong or you don't agree -- I think, to me, it is to try to get disposed waste below the blue house and the red corn, the red soil corn.

(Laughter.)

CONSULTANT FLACK: Oh, okay.

CHAIR RYAN: That it is more uniformly-handleable in an exposure scenario. I am just trying to get the words that help people understand what exactly is --

MS. RIDGE: Blending is driven by the tables right now.

CHAIR RYAN: Never mind right now.

MS. RIDGE: Okay.

CHAIR RYAN: Where are you heading? If the factor-of-10 rule goes away, do we end up with more homogeneous waste that I can better describe, once disposed, or not? That is really a key question to me.

MS. RIDGE: If the factor-of-10 rule goes away, then you will have created more waste that is Class A, but at the higher end of Class A.

CHAIR RYAN: There's nothing magic about that high end of Class A?

MS. RIDGE: No.

CHAIR RYAN: It is more uniform. Therefore, it is more kind of understandable in the context of the performance assessment?

MS. RIDGE: It should be more uniform, and that is part of what the homogeneity guidance was created to address, is how uniform is it. Because without the homogeneity guidance, there is no reason to assume it would be more uniform. That is what the promise is, but there is no guidance around that. You could put something in a barrel and not mix it and call that blending. Now that isn't what anyone said their intention is, but that you could do. And so, the homogeneity guidance is really to address that issue, to say how uniform is that going to be.

I'm not sure I 100 percent agree that there's nothing special about the top end of Class A because the different waste classes are subject to different disposal requirements. And so, what you are doing is you are moving some waste that would have been disposed of as Class B with those requirements around. It will now be blended so that it is Class A waste and is, quite probably, more uniform. It is more dilute, and therefore, for those reasons, lowers the risk to an intruder. But it will be disposed of under different disposal conditions.

And so, whether it is good or bad for an intruder is entirely up to how it is implemented. I don't think it is inherently good or bad for an intruder. That part is up to the implementation.

CHAIR RYAN: I think on the blending part

I understand and appreciate what you are saying. The hard part, though, is not the blending aspect. It is the fact the probability of intrusion is what? That is where it falls apart because it becomes automatic that that is a real case, and there is no reason to accept that or believe that. Depth-of-burial and other kinds of burials could impact that probability.

MR. COCHRAN: Let me add another factor to try to answer your question, John. It is very practical.

Right now, in America that is a disposal facility that can take Class A waste, the least active waste, from all 50 states. But if you are generating B and C, the higher-activity waste, and you are one of 36 states, there is no disposal facility that can take it. But if you blended it with a lot of low-activity A, so that your B and C ion-exchange resins become A when blended, then you have got a disposal pathway. So, there is a very practical driver behind this.

CONSULTANT FLACK: Yes, okay.

MR. COCHRAN: Does that make sense that right now --

CONSULTANT FLACK: Well, yes, it does. I am trying to look at it from a societal risk perspective, if there is any change here to the human population, the risk that it's being exposed to.

We keep coming back to the intruder's risk, but in this case you are talking about a societal risk. Now you have large quantities that could expose many people, and now you want to put it into places that get away from that situation. And that changes the risk profile.

But now you are left with an intruder profile, which is the last one that you look at to make sure, inadvertently, it doesn't get hit. So, I am trying to keep these two separate in my mind, the societal from the intruder.

But, anyway, thank you. That helps a little bit.

CHAIR RYAN: Okay. Go ahead.

MS. RIDGE: I would agree that this is a consequence analysis, and maybe that helps. So, we acknowledge that this is a consequence analysis for the intruder.

The probability of intrusion was considered only subjectively and --

CHAIR RYAN: Well, so far, the low-level waste is zero. The actual probability is zero. All right, yes.

MS. RIDGE: And it remains to be seen, I

think, what happens after the waste sites are closed for 100 years.

CHAIR RYAN: We'll see.

MS. RIDGE: We'll see. We'll see.

MEMBER ARMIJO: Yes, that's where we get into what is society like, will we have a government, will we be a bunch of transients wandering around looking for a home. You know, when you get into such a subjective arena, it is not engineering anymore.

MS. RIDGE: Fortunately, I think you will see that we are talking about a shorter timeframe than you may have had in recent discussions on other --

MEMBER ARMIJO: Yes, the last one I was in was 20,000 years. So, 300 years, I can say, hey, we might still have a country then.

CHAIR RYAN: Well, the good thing is there will only be five radionuclides left.

MEMBER ARMIJO: Yes, but, well, 300 years, I can deal with that. I mean it is 20,000 years that got me.

MS. RIDGE: The first thing I want to point out on this slide is that I am not proposing that someone exhuming a small amount of waste is at a greater risk than someone exhuming a large amount of waste. And I want to be very clear on that.

I am not at all proposing that someone drilling a well is somehow at a greater risk than someone building a dwelling and exhuming the amount of waste that you would exhume to build a dwelling. That is the scenario that was considered for the Part 61 intrusion analysis.

So, what I am showing here on the left is the Part 61 intrusion analysis and then contrasting that with an alternate conceptual model of a hypothetical intrusion scenario that drives the homogeneity guidance.

All I am suggesting is that, if you are looking at waste homogeneity, you have to consider, if your concern is how well waste is mixed, then someone exhuming a small amount of waste is going to see hotspots more than someone exhuming a large amount of waste. Someone who builds a dwelling and exhumes a large amount of soil is going to mix that waste, and to whatever extent they don't mix, by moving around the property, they are going to average their own exposure to that waste. Someone who exhumes a very small amount of waste could hit hotspots in that waste.

And so, I am not proposing that someone exhuming a small amount of waste is at greater risk.

All I am proposing is that, when specifically you are trying to develop homogeneity guidance, you need to look at someone exhuming a small amount of waste.

Now there are a few things I want to point out the differences here. Part 61 assumed that the waste was fairly shallow; someone did put a house in the waste. It also assumed that the waste, when it was emplaced, by chance, was mixed. It was randomized. And so, you were not going to pull up in the size of a basement of a house a great deal of waste that was all dominated by the same radionuclide, was all at the limit, because this waste was all going to be randomly-placed. And that was an assumption in that analysis and it is built into some of the numbers in those tables.

Now when looking at the homogeneity guidance, we considered a few things. One is that waste typically is actually disposed of more deeply than was assumed in the development of Part 61. Right there, that limits the scenarios.

CHAIR RYAN: Should we move on to your next slides or do you want to stay on this figure? You're talking from your upcoming slides? It's up to you.

MS. RIDGE: Well, I was still talking to

this.

CHAIR RYAN: Okay. All right. That's fine. All right.

MS. RIDGE: I'm almost finished with this slide.

And so, we, for those reasons, looked at a well-drilling scenario.

We can move on to the next one.

Okay. Now, as I mentioned, homogeneous waste types are those waste types that are assumed to be homogeneous in the context of intrusion. The list that is in the BTP is listed here. No additional test is proposed for designated waste types. For these waste types right now that are treated as homogeneous waste, they are assumed to be equally-mixed, as we discussed. In some cases, they are assumed to become easily mixed.

And the only thing we are proposing is that, if you are a waste classifier, so a generator or a processor, and you are surveying the waste for some other reason, for instance, for transportation, if you develop information that shows that the waste is not homogeneous, that you would consider that and ignore it.

And specifically, what I mean by not

homogeneous is the crux of the guidance, which is that no cubic foot of the waste should be more than 10 times the class limit. And I will talk more about that on the next slide.

CHAIR RYAN: So, you are going back to the factor of 10 that you just took away?

MS. RIDGE: The factor of 10 is moving from the inputs to the output, which is a different thing. Because if it is on the inputs, it limits what types of processing you can do.

CHAIR RYAN: Yes, I see your point.

MS. RIDGE: Next slide.

CHAIR RYAN: Is that how you take away the fact that, without that kind of a rule, that there could be very wide variability interpreting those criteria that are on slide 20?

MS. RIDGE: Yes.

CHAIR RYAN: I mean, I could see different Agreement States having different views of that, coming out of the box, for the different systems.

Okay. Thanks.

MS. RIDGE: So, this guidance was based on the --

CHAIR RYAN: Sorry, Christianne, just one more question.

MS. RIDGE: Yes.

CHAIR RYAN: Why a factor of 10? Why not 20? Why not 30 or 5?

MS. RIDGE: Well, you anticipated my next statement. The guidance is based on the scenario that I just showed you two slides ago. So, it could have been that we developed guidance around a factor of 20. The factor of 10 is consistent with how we currently do mathematical averaging. And it is a number that corresponds, when you look at the scenario, the well-drilling scenario I just showed you, the factor of 10, the amount of waste you would have to exhume corresponds to an amount of waste that is detectable essentially. If you went to a factor of 20, the volume that that would correspond to would be smaller, and it becomes more difficult to detect that and do surveys around that number.

So, we are on this point very much interested in the comments we are going to get from stakeholders on the factor of 10 and the cubic foot. It may be that regulation around a factor of 20 at a smaller volume is both protective and more implementable. It may be that a guidance that is around a smaller factor, but a larger volume, is protective, yet implementable. And that is something specifically that we are really looking forward to stakeholder comments on.

But the factor and the volume that it corresponds to in that scenario are obviously linked. And essentially, the details of the scenario are described in the Appendix B of the BTP. But, essentially, that is a volume and a factor for exhuming Class A waste at 100 years or Class A at 500 years, that gives an intruder risk at half the limit.

Half the limit was used because, if you put in a well, you are exhuming other waste as well. And so, that subjective allowance was given. So, that is where those numbers come from.

CHAIR RYAN: One thing the factor of 10 or 20, or some other number, it really depends on what radionuclides you happen to be dealing with. Because some of those radionuclides, as you well know, as I am sure everybody does, the dose conversion factors per unit of activity can be very different. So, that factor you derive is very specific to the dose conversion factors for those radionuclides, right?

MS. RIDGE: Don't lose sight that there is a great deal of mixing that is already assumed. So, we are looking at a dose conversion factor for someone exposed to a plane source after this has been mixed into the soil for someone consuming crops. So, it is not quite the same problem as looking at sealed sources.

CHAIR RYAN: Well, let's say I take carbon-14, which has essentially no dose rate.

MS. RIDGE: Right. And this guidance is based on the most limiting radionuclide. Now for Class C --

CHAIR RYAN: Ah, so it is bounded by the most conservative radionuclide from this standpoint? That's deterministic.

MS. RIDGE: Yes.

CHAIR RYAN: I mean, it kind of takes away from the operator of a site the ability to judge what he has instead of what is a limiting case.

MS. RIDGE: And I think that if your waste weren't one of those limiting radionuclides, certainly a case could be made for using a different homogeneity guidance.

CHAIR RYAN: Yes. That might be something to think about adding --

MS. RIDGE: And that may be something we should specifically list.

CHAIR RYAN: -- as an alternative.

MS. RIDGE: I think that that makes a lot of sense.

CHAIR RYAN: Yes. Okay.

MS. RIDGE: I think that that makes a lot of sense.

CHAIR RYAN: You know, anytime you build a construct of any of these kinds of types that we have talked about a couple, it would be really helpful to have, and if you have different radionuclides or a different set of circumstances where you want to propose an alternative, it is the structure of that alternative that you need to follow.

MS. RIDGE: And we did -- and John will talk more to that.

CHAIR RYAN: Okay.

MS. RIDGE: We did list several of those. This is another one that I think makes a lot of sense.

CHAIR RYAN: Okay.

MEMBER ARMIJO: How does somebody go about demonstrating that he meets your homogeneity requirement? Let's say you have got tons of resin, and they come from different batches from his site. The resins were generated when there were a lot of field failures and there's a lot more stuff in there --

MS. RIDGE: Right.

MEMBER ARMIJO: -- than resins that come from a normal operation, a clean plant. And he wants to mix them. So, he puts them in some sort of a blender.

What does he have to do to demonstrate that he has met the 1 cubic foot with some fractions greater than 10? How do you actually go about that? What is expected?

MS. RIDGE: We are imaging that in most cases, and it comes something to that point in the second bullet, but we are imagining that in most cases the test would be applied to the mixing apparatus. In plants, for instance, I think there is typically a recirculation loop on resin tanks. In a blending apparatus, it may be a completely different construction.

But, essentially, we are envisioning that a lot of this could be done through surveys, that there are some scaling factors that could be made, so that you can do this through surveys. I think the number of samples you would have to take would be certainly burdensome if you were trying to show that there are no cubic feet that --

MEMBER ARMIJO: Yes, that's what I was trying to get at. How do you prove that?

MS. RIDGE: That sampling would be impossible. But we are making an assumption at this point that, for most waste streams, there is some scaling factor that could be made, so that this could be done through surveys. And then, for instance, if waste were moving by in a recirculation loop, you could just look at the flow rate --

MEMBER ARMIJO: Yes.

MS. RIDGE: -- and say, well, you know --

MEMBER ARMIJO: If it is amenable to blending, why it's --

MS. RIDGE: -- if there blips to this number for this amount of time, that would correspond to a cubic foot; you're okay.

MEMBER ARMIJO: Okay.

MS. RIDGE: You know, this also could be applied to individual containers. But if we are talking about intentional blending during processing, we are assuming that this would be applied to the process, and then that demonstration that the process is creating homogeneous waste would remain until there was some change in the process or some significant change in the inputs.

Now, I mean, the simple matter is, if you did have enough knowledge of your inputs to say it already met a factor of 10, then none of this would be necessary. So, we are assuming that, you know, if you are talking about blending wastes, that the inputs differ by a factor of 10, then you have to look at the outputs.

MEMBER ARMIJO: Right.

MS. RIDGE: Obviously, if you have enough information about the waste streams to say that they already are within a factor of 10, then this is unnecessary.

But if you are talking about blending waste to have more different concentrations, then we are assuming in most cases this would be applied to the process itself. It could also be applied to individual waste containers, although it seems like that would be more difficult. But maybe it wouldn't. Certainly, we could get comments on that as well.

Next slide.

This is my last substantive slide. We really need to let John talk because he has most of this information.

But I did want to mention that we also included some guidance on the classification of homogeneous waste. This would not necessarily be limited to intentional blending during processing, but it was intentional blending during processing that made us think about guidance for waste that is very near a classification limit.

Now this guidance hasn't been quantified in NRC guidance previously. But guidance about more rigorous consideration of the uncertainties for waste that is near a classification limit is consistent with the 1983 Branch Technical Position on Waste Classification. That Branch Technical Position indicates that, if you have a process where a small change in the process could change the waste classification, then you need to more rigorously account for uncertainties in the process.

And so, we provided some guidance. Our proposed guidance is that the sum of fractions should be less than one minus the standard error. So, essentially, the mean sum of fractions, you look at the standard error around that, and you want to clear the bar where you are within a sum of fractions, you're within a standard error of your waste classification limit.

Now, if you are considering a once-filled test because you are only concerned about being below the classification limit, and you gather enough samples and you make some assumptions about your waste, the number being, the error being random, then that corresponds to approximately an 85 percent confidence interval. That selection is subjective, and we will certainly get comments on that. But that is the proposed guidance.

CHAIR RYAN: Why did you pick that one?

MS. RIDGE: I think I just thought it was subjective.

(Laughter.)

CHAIR RYAN: Why not some other number? Okay, it's a starting place. I'll take it as a starting place.

MS. RIDGE: This is a starting place. This is a starting place, and we are going to get comments on this.

CHAIR RYAN: Okay.

MS. RIDGE: And essentially, we are just asking folks to rigorously consider these uncertainties.

MEMBER ABDEL-KHALIK: How do you assure compliance with that third bullet?

MS. RIDGE: We don't mean to assure compliance because this is guidance. But what we would ask folks to do is to look at the spatial variability, which we anticipate would be a source of uncertainty, and to look at the mean of the readings they have for the spatial variability. We would ask them to look at the uncertainty in scaling factors, which we think would also be another factor.

Now there may be other factors that contribute significant uncertainties. These are the two we thought would be most significant.

And we would ask, if you are near the sum of fractions of 1, that we would see, what is the variability in your scaling factors? What is your spatial variability? And then, propagate those errors.

MEMBER ABDEL-KHALIK: And the length scale or the volume scale of 1 cubic foot, what is the basis for that?

MS. RIDGE: That, the 1 cubic foot, is sort of part and parcel of looking at 10 times the class limit. If you have a cubic foot that is 10 times the class limit and you exhume that when you are digging a well and spread it on the surface, for your most limiting radionuclides -- and Dr. Ryan made a good point --

CHAIR RYAN: Bounding analysis.

MS. RIDGE: Right. Dr. Ryan made a good point about us looking at only the most limiting radionuclides. Then that gets you to an intruder dose of 250 millirem per year.

Now there are assumptions built in there about how deep the well is, how much you spread the drill cuttings, how large of a garden you have. There are certainly assumptions built into that.

We looked at those probabilistically. So, we considered our range of well depths, a range of cutting areas, a range of garden sizes.

CHAIR RYAN: How do those match up --

MS. RIDGE: But that is how those two things, the cubic foot comes with the 10 times the limit.

CHAIR RYAN: I am sure, John, you have done this, but if you take a look at those kinds of parameters that are existing in closed low-level waste sites, how does it match up to what you assumed?

MS. RIDGE: At closed low-level waste sites?

CHAIR RYAN: Yes. Or operating ones.

MS. RIDGE: I am unaware of intruders having drilled wells --

CHAIR RYAN: Well, I mean, the depth of wells and all those other kinds of parameters that are known.

MS. RIDGE: You mean in the regional areas?

CHAIR RYAN: Yes.

MS. RIDGE: I don't know.

CHAIR RYAN: I mean, I would think you would want to get some anchor to say that this within reason --

MS. RIDGE: Right.

CHAIR RYAN: -- within the world of low-level waste sites, federal and commercial, in the U.S.

MS. RIDGE: The numbers, the ranges that we used were related to the original Part 61 analysis.

CHAIR RYAN: That's ancient history.

MS. RIDGE: And that could be updated.

CHAIR RYAN: I don't think that is reflective of probably the range of reality for those kinds of parameters. I think it would be instructive at least. You know, maybe it confirms where you are; I don't know. But I would try to get some sense of what is the depth, the real depth, of wells in that distribution for monitoring and other parameters that feed into your analysis to say, are we on home plate or are we way out in left field somewhere in the corner? I think that is a useful thing to think about.

Thank you.

MEMBER SIEBER: Have you ever done an analysis where you presume that the waste packager was trying to get rid of some hot stuff and goes to the limits on all this?

(Laughter.)

And how that impacts the waste package after it has been disposed of?

For example, there is a fair amount of variability here, you know, the factor of 10 and all of that. I think every radcon manager sometime in his career has ended up with a hot pistol you would like to get rid of without paying a million dollars to do it, you know.

Have you taken a look at the regulations from that standpoint?

MR. COCHRAN: The classification limits, we talk about Table A, Table B, and Table C.

MEMBER SIEBER: Right, Class A, right.

MR. COCHRAN: The way those were developed was the NRC, through the rulemaking process, developed some reasonably foreseeable, yet conservative, exposure scenarios. Like someone might inadvertently construct a basement into where the waste was buried and not recognize it. Or if they did recognize it, they would back away after six hours. Two different exposure scenarios.

And in the scenario where the waste is not recognizable, it is fairly homogeneous, it is mixed in, soil and ask, they construct the basement and then some of the cuttings go in a garden, and then in the garden they eat some of the vegetables.

And the dose limit for the inadvertent human intruder is 500 millirem. They, then, back-calculated the concentration of each of the nuclides that would give you 500 millirem. So, those standards were set to give 500 millirem, the dose standard for the intruder, for each of the nuclides. Then, we used something called sum of fractions to account for having multiple nuclides in a disposal cell.

Now, unfortunately, the story is a little bit more complicated than that. I don't want to go into it. But the simple story is, they were back-calculated. These specific activity limits, like 4,600 curies per cubic meter, were back-calculated to give the intruder 500 millirem. So, they were set at the dose limit, the maximum dose limit.

And the story is a little more complicated, and unless we really want to tell a complicated story, I would like to leave it at that.

MS. RIDGE: Well, I would like to leave it. I don't want to go into it. I know we don't have a lot of time. But I think we do need to point out that factors were applied to those numbers after that to account for various objective considerations. And so, the numbers that are in the table don't right now correspond to an intruder in these scenarios getting 500 millirem, because factors were applied after that. And I think we can leave it at that.

But I want to point out that you can't just take those numbers right now and get to 500 millirem. You get to a number higher than 500 millirem.

CHAIR RYAN: Tell me if you don't agree, but I think it is a fair observation that this is not risk-informed; it is really deterministic.

MS. RIDGE: Which part?

CHAIR RYAN: That does calculation you just described. I don't think it is very risk-informed. I think it is very deterministic and based on the assumptions that you make. And one analyst could very easily make other assumptions and come up with a very different number, up or down.

MR. COCHRAN: The point that I would add to that --

CHAIR RYAN: Do you agree or disagree? Am I wrong or?

MR. COCHRAN: Well, let me just add my point and then we can --

CHAIR RYAN: All right. All right.

MR. COCHRAN: My point is that the NRC, in developing these standards, held eight or ten regional meetings, a draft EIS, a Final EIS, a rulemaking process, public meetings. And so, these what appear to be subjective exposure scenarios were developed with the public input.

So, one could say, to some degree, these represent the level of protectiveness that the society has selected.

CHAIR RYAN: That's all fine, but that is not what I am asking about. I am asking about the technical correctness of what the assumptions are compared to what reality is. That is a whole separate issue.

MR. COCHRAN: I mean, they are risk-informed into the --

CHAIR RYAN: And I think -- go ahead.

MR. COCHRAN: They are there to protect the inadvertent human intruder, should the intruder inadvertently dig into the waste.

CHAIR RYAN: I mean, are we guaranteed that that goal is accomplished? I just don't see why or how one can conclude that it will meet that goal because there is lots of variability in all the assumptions that went into that scenario.

MR. COCHRAN: You can't anticipate all.

CHAIR RYAN: So, there is no certainty that that is too much or enough? Or too little?

MR. COCHRAN: Again, through the rulemaking process --

CHAIR RYAN: I understand there's been lots of comment, but that can be either technical or non-technical and a wide range of views in that. So, I mean, that is one factor to take into account, but that is not the analytical process to me.

MR. COCHRAN: Well, as we have discussed, there is no way of actually assigning a probability to any future scenario.

CHAIR RYAN: Wow! It cannot be risk-informed then. It cannot get the "how likely is it?"

MR. COCHRAN: Well, it is risk-informed in that it is protective of the inadvertent human intruder. Remember, this is not probabilistic risk assessment. We sound a little like a broken record to each other.

CHAIR RYAN: Okay.

MR. COCHRAN: But this risk-informed, not probabilistic risk assessment.

CHAIR RYAN: Oh, I don't disagree.

Okay, go ahead.

CONSULTANT FLACK: It sounds more like defense-in-depth.

MEMBER ARMIJO: Yes.

CONSULTANT FLACK: Not risk. But you are saying I am going to defense against this.

MR. COCHRAN: Yes, should this occur.

CONSULTANT FLACK: It's defense-in-depth. I don't see the risk here because risk is probability times consequences. Without the probability, I don't know what the risk is. I mean, we could talk about consequences all day long and try to protect. Okay. So, we don't know, so we are going to put in defense-in-depth, period, end of story.

But I am just trying to understand, you know, maybe deep inside everybody they have likelihoods of these scenarios. But I don't know what they are at this point now.

MR. COCHRAN: Yes, and deep inside we might have different gut feelings about --

CONSULTANT FLACK: Might have a different probability.

MR. COCHRAN: And pretty soon in my presentation, I will present one to you.

(Laughter.)

And get your gut response to it.

MS. RIDGE: I think we need to let John get to that.

This is a quick table of some of the main changes to the BTP and the ones that I have talked about. I don't want to belabor this. The only thing I want to point out is that the second one I have highlighted is in the 1995 BTP there was an exception to the factor-of-10 rule. We eliminated that exception, but only because we eliminated the factor-of-10 rule. So, that is somewhat clear.

I think we can go on and let John speak.

MR. COCHRAN: Good afternoon.

CHAIR RYAN: Good afternoon, John.

MR. COCHRAN: Next slide.

So, I am going to review three elements of the guidance and the technical basis for those three elements.

One is how to classify a mixture of individual items in a container: the activated metals, contaminated materials, or cartridge filters.

The other is the BTP's position on encapsulation of sealed reactive sources and like materials.

The third is alternative approaches.

I am going to review these in reverse order because they build on each other.

Next slide.

And let me go sort of off-course for just a second. The BTP is about classifying waste under Part 61. If we had another hour, it would be great to talk about Part 61 because this is guidance for using Part 61.

And I see the look on your faces. You want to understand this, but it is a little tough.

CHAIR RYAN: John, we may take you up on that in a little bit.

(Laughter.)

MR. COCHRAN: I would actually like to do that.

CHAIR RYAN: Very good.

MR. COCHRAN: I would like to do that sometime.

CHAIR RYAN: Yes, we will plan on it.

MR. COCHRAN: And we could probably disagree on some of the bases, but that is okay. I think it would be very meaningful for the group here because the BTP is about classifying waste using Part 61. Anyway, that is off-course.

So, let me talk about alternative approaches first. And if you have had a chance to look in the revised draft of the BTP, you will see there is alternative approaches and alternative provisions. And so, let me separate the two.

Alternative provisions, that is in the 1995 BTP. What it says in a nutshell is, if you would like to deviate from the BTP's guidance, you should do it by seeking a deviation from the regulation. Well, that's a pretty high bar to set.

So, in the revised draft of the BTP, if you look under alternative provisions, it says there may be some circumstances where you need a deviation from the regulation. If you need a deviation from the regulation, seek a deviation from the regulation. If, though, you need a deviation from just the guidance, then that is what alternative approach is about. Alternative approaches are new to the BTP.

Next slide.

And really, they represent a new philosophy in implementing the BTP. Where the BTP sets broadly applicable look-up values, and that gives us a uniform level of safety for the implementing Agreement States, then the alternative approaches provides the licensees in the Agreement States with specific NRC guidance on factors to consider when deviating from the guidance. So, this is new to the BTP.

Uniform threshold, easy to use. Look it up in the book. Then, if you need to deviate, alternative provisions provide both the licensees and the Agreement States with things to consider when deviating.

So, let me give you a quick example, and I hope we don't get distracted. Let's say I'm a licensee. I've got a 20-curie sealed radioactive source here, cesium-137 source, and I've got a 200-curie one.

Kind of hollow (referring to visual aids). I'd better do it like that.

(Laughter.)

I have tried to send them back to the manufacturer. He won't take them. I have tried to recycle them. You can't recycle them. I need to dispose of them.

So, I look to Part 61, and this 20 curies, let's say it is in a cubic inch. The BTP for cesium-137 gives everything in curies per cubic meter. So, I scale this 20 curies in a cubic inch up to curies in a cubic meter. I have got a terrible problem. This is like 3 million curies now per cubic meter. So, I've got a problem.

I go to the BTP. The BTP says I can encapsulate this in concrete and average over the encapsulating media. And it even has a specific table in here for cesium-137. And so, I have got a disposal pathway for the 20 curies.

Now the 200 curies is too big. I don't have a disposal pathway yet. I go to the alternative provisions, I'm sorry, alternative approaches. And I see in alternative approaches that for sealed sources, if I am able to bury them deeper than 10 meters, and in a source housing that would be very difficult for the intruder open, that might be acceptable.

Okay. So, now I have a basis for seeking deviations from the guidance. And the basis that I see as a generator is the same basis that the Agreement States see. Okay.

So, I have got easy-to-use lookup values. Where I exceed those values, I have got the alternative approaches.

So, what we are doing is we are --

MEMBER BLEY: The alternative approaches it sounds like are not automatically acceptable. It is a suggestion that can be brought forward.

CHAIR RYAN: Dennis, if you could maybe get a little closer to your microphone? We are having a little trouble hearing you.

I'm sorry, this is Dennis Bley, a Member of the Subcommittee and the ACRS on the phone, B-L-E-Y.

Go ahead, Dennis.

MEMBER BLEY: Yes, I just said it sounds as if the alternative approaches, then, are not acceptable at face value, but offer a way, an alternative, that people can come back and propose to you.

MR. COCHRAN: That is correct. That is correct. It's not automatic. If it were automatic, it would be in the guidance, right?

Next slide.

So, I have just talked a little bit about encapsulation. So, let me go through the encapsulation policy.

Next slide.

And if you are not familiar with encapsulation, it is the process of surrounding a radioactive item, like a sealed source, with a binding matrix, like concrete, in a container, where the radioactivity remains in the dimensions of the original item.

And we encapsulate things for several reasons. One, to meet stability requirements. Another is to provide worker protection in the disposal facility. And a third is that the BTP allows one to average the curies over the encapsulating media. Okay. So, maybe the 20 curies are here, but I can average it over the volume of the encapsulating media.

So, a lot of good reasons to encapsulate. As you can imagine, I think you brought up, in fact, that this could be abused.

MEMBER SIEBER: Yes, sure.

MR. COCHRAN: Right? Someone could encapsulate over the volume of a small house or something to get rid of waste that otherwise would be unacceptable for near surface disposal.

MEMBER SIEBER: If it will fit on a truck.

MR. COCHRAN: Yes.

Next slide.

Let me review, first, the 1995 BTP guidance. It sets limits on encapsulation. It sets a limit on the maximum volume. That limit is .2 cubic meters, basically, a 55-gallon drum worth.

And then, if you have got a non-gamma source, a strontium-90 source, the maximum curie limit is that limit that would meet the Class C limits when averaged over the encapsulating volume. So, it is basically the number of curies that you could have in .2 cubic meters or the number of curies you could have in a 55-gallon drum.

CHAIR RYAN: What's the largest drum I can use? How about an 80-gallon drum? How about 150? Maybe a 300-cubic-foot? Why are we picking one particular container?

MR. COCHRAN: No, no, no, no.

CHAIR RYAN: Okay, John, I know you have thought through all this.

(Laughter.)

MR. COCHRAN: First, I am reviewing the 1995 guidance. Okay?

CHAIR RYAN: Okay, but -- all right.

MEMBER ARMIJO: So, that may go by the wayside.

MR. COCHRAN: And then, finally, there are curie limits for the gamma emitters as ell.

Next slide.

Now those curie limits for the gamma emitters were set based on an intruder exposure scenario that is in the back of the 1995 BTP. You can go look it up.

And a part of that scenario envisions that the intruder would be exposed to an encapsulated source 1 meter away or 2,360 hours. Okay? Sort of a little --

MEMBER ARMIJO: Pretty specific.

MR. COCHRAN: Pretty specific, and maybe doesn't seem reasonable to us today that the intruder would be 1 meter away from an encapsulated sealed source for 2,360 hours. And so, staff set about developing what we hope is a more reasonable scenario.

But, based on that exposure scenario, in the 1995 BTP there are limits for disposal through encapsulation of gamma-emitting sealed sources. I am not going to go through the limits except to point to cesium at the Class C limit, 30 curies. So, that is the largest cesium source that could be encapsulated under the 1995 BTP.

Next slide.

So, now I am going to talk about the revised draft of the BTP. The maximum encapsulating volume remains at .2 cubic meters with the opportunity to implement alternative approaches. And for the non-gammas, also unchanged, it would be the Class C limit when the non-gamma source is averaged over the encapsulating volume.

CHAIR RYAN: I peeked ahead, and I saw no change, but there actually is an alternative for change on the first bullet, the alternative method, right? Did I understand that right? In fact, the maximum volume is still .2?

MR. COCHRAN: It is, that's correct, the difference being alternative approaches now.

CHAIR RYAN: Okay.

MR. COCHRAN: But the maximum volume is still .2.

Now for the gamma-emitting curie limits, the staff wasn't sure that this exposure, 1 meter, 2,360 hours, seemed reasonable. And staff set about developing a different exposure scenario.

Next slide.

CHAIR RYAN: Just to pick on the .2 meters a little bit, I am curious, why not .3 or .4?

MR. WIDMAYER: Mike, I think it is based, if I am not mistaken, on the fact that a concrete-filled, 55-gallon drum is reasonable to --

CHAIR RYAN: I know, but why not an 80-

gallon drum, or some other size drum?

MR. WIDMAYER: Well, because it wasn't reasonable to be moving that gigantic barrel around with concrete in it.

CHAIR RYAN: It's not that heavy.

I'm just curious. I know it is a standard drum that is used in standard shipments, but if a small change could accommodate a waste and still meet the criteria, I don't see why there isn't an alternative to do that.

MR. COCHRAN: And now there will be if we implement the alternative.

CHAIR RYAN: Okay.

MR. COCHRAN: I mean the new BTP.

CHAIR RYAN: With a little bit more specificity, you know, you can use a different size drum, you can look at alternatives. I think the more specific you are, the better off it will be.

MR. COCHRAN: We are fairly specific. I don't know if you have had a chance to look at look alternative approaches for encapsulation, but it is fairly specific about things you can do.

CHAIR RYAN: Okay. Thank you.

MR. COCHRAN: So, the next six slides are on developing the new exposure scenario. We call it the gamma-emitting, sealed-source, carry-away scenario.

And in developing the scenario, we reviewed accidents with sealed radioactive sources. And it is our understanding that accidents with sealed sources were one of the drivers for the development of the BTP to begin with.

Part 61 envisioned one of two things. Either the waste would be homogeneous, they wouldn't recognize the hazard, they might build a basement in it or a garden in it, or the waste would be recognizable and they would back away.

But with these small sealed sources, the concern was that maybe these sealed sources might survive, but the hazard wouldn't be recognized. So, it was in between the two.

We can go to the next slide. I'll get to it a little bit later. I've got a point I want to make.

So, we reviewed sealed-source accidents. These are three. We reviewed about five of them. These were all prominent accidents.

There was one in Egypt we also reviewed. There was one in Morocco. That one killed eight people.

I'm not going to talk to them except the one in Goiania. That was the most interesting. In 1987, in Brazil, there was a semi-closed medical clinic. A couple of people entered the clinic with a wheelbarrow. They went to a cancer-treating machine, a teletherapy machine, pulled the head off, put it in the wheelbarrow, took it to a scrap metal dealer, disassembled it.

And in the center of the head, they found a stainless steel capsule in the very middle of it. That seemed pretty interesting to them, and they cut it open. And when they cut it open, they exposed the cesium chloride powder that was in it. They didn't recognize the hazard. It didn't smell bad. It didn't look bad. It didn't produce heat. They didn't recognize the hazard whatsoever.

And, in fact, in low light, this powder kind of glowed a bluish glow. It seemed like magic powder.

It got spread around. In the end, four people died, including a little girl. It spread throughout the city because it was a dispersible powder. It took several years to clean up.

So, this is a real instance with a sealed source.

CHAIR RYAN: I think that is clearly a tragedy. There's no question about it. But it is a leap to get from an abandoned source as opposed to a disposed source that is licensed, and how you can make kind of direct comparisons. I mean, sure, there will probably be other events in the world where materials are abandoned and fall into ill use, as you describe. But I'm at a loss to try to get to the reach where this is the same kind of consideration or should drive the consideration for properly and licensed disposed low-level waste.

MR. COCHRAN: Next slide. Maybe I will address your concerns.

So, looking across the accidents, there were a number of common elements: loss of regulatory control. In every case, the source fell out of regulatory control, whether it was the radiographer who lost his radiography source, his radium source, and didn't report it to the authorities, or a medical clinic that had been closed, or a teletherapy machine that ended up in a storeroom somewhere.

The victims were engaged in normal activities: a farmer in Egypt, scrap metal dealers and soldiers in Georgia.

The hazard was unrecognizable in every

case. There was nothing to tell them that there was gamma radiation here. Their sense failed them.

Most of the accidents resulted in fatalities, adults and children.

And when viewed broadly, these are all unlikely. I mean, there are millions of sealed-source applications in a year and only a few big accidents like this. So, they are unlikely --

MEMBER ARMIJO: But those were all surface or near-surface --

MR. COCHRAN: Yes, yes.

MEMBER ARMIJO: -- situations. And you see something that small. Why isn't the best solution just simply drilling a hole, keeping it small, maybe putting it in some capsule, and getting it out of the way? The probability of finding it diminishes tremendously by something pretty straightforward. Drill a well, not a well, but a hole. It seems to me like that is amenable to analysis, just this probability of encountering it. Where it is near surface, you start getting into a human activity, which these are all normal and common activities.

MR. COCHRAN: Yes. The probability of someone inadvertently drilling into a source or finding a source that is buried in subsurface isn't actually knowable because you don't know if societal practices will stay the same for hundreds of thousands of years or change or technological knowledge --

MEMBER ARMIJO: John, I don't know if there's thousands of those little disks --

MR. COCHRAN: Millions, actually.

MEMBER ARMIJO: -- or millions of them, but let's say you were in a big disposal site and you decided, okay, in this big disposal site we are going to allow deep burial, seal them properly, whatever, whether it is in concrete or a smaller capsule. But a small thing is harder to find than something that is uniformly distributed or millions of them.

So, is that part of what your process -- would you permit that? Would you give credit for that? The probability of finding those things in a big site is really small.

MR. COCHRAN: It is an argument to bring to bear, but I don't think it is a sole decider because you just don't know what the future will bring.

Let me proceed because, again, I have got six slides on this exposure scenario. Maybe I will be able to answer some of your questions.

MEMBER ARMIJO: Okay.

MR. COCHRAN: Next slide.

So, the scenario that is proposed is not real. We don't know that this is going to happen or not. Rather, it is a stylized scenario used to ensure that the intruder wouldn't see an inordinately high dose, should intrusion occur. We are just being protective.

CHAIR RYAN: You know, I understand your comment. You think that you feel that is protective. But is it necessary to be that protective based on the fact that there is no real risk insight into the scenario? I mean, I understand the surface examples. They are all tragedies. There's no doubt about that in anybody's mind.

But we now have a situation where we have got a source, just like the ones in front of you, the quarter and the piece of tin. And that is now in a 55-gallon drum buried 40 feet down below a concrete barrier, below a multilayered cap, maybe even a sign that is put on the top of the cap that says, "Radioactive material. Do not dig."

And we need to somehow recognize that there are many opportunities for that intruder to become aware. And by the way, it is pretty tough to get through, as you well know, a foot of reinforced concrete without some very serious equipment.

So, I find the example a little bit poorly-informed about the more reasonable set of circumstances that are likely to be found in any low-level waste site in the United States.

MR. COCHRAN: Let me proceed through the --

CHAIR RYAN: Sure.

MR. COCHRAN: -- description of the scenario, so you understand the basis. Why don't we take a look at accidents to see the circumstances of accidents? What we are proposing isn't real, but, rather, stylized, to protect the intruder, should intrusion occur. Let me go ahead and develop the scenario that was then used.

So, we are now 500 years in the future. There is an old low-level waste landfill. There has been a loss of control, recognition, and knowledge of the landfill.

Inside the landfill, the containers and the wastes have decayed, rotted away. Even the concrete has gotten kind of rotten over 500 years.

However, the stainless steel radioactive source has remained intact. Stainless steel is very decay-resistant.

Next slide.

MEMBER ARMIJO: I'm sorry, John, would you go back?

Is this thing in this concrete?

MR. COCHRAN: It began as an encapsulated sealed source.

MEMBER ARMIJO: And it was put in -- okay. So, it is stainless steel with this concrete in a barrel.

MR. COCHRAN: That's correct.

CHAIR RYAN: And maybe, just maybe, a stainless steel drum instead of a carbon steel, which is what you assumed.

MEMBER ARMIJO: It depends on what you bury it in.

CHAIR RYAN: Yes.

MEMBER ARMIJO: Stainless steel is, if it goes anaerobic, it is not that good.

MR. COCHRAN: And certainly, there are arguments about concrete should last thousands of years. Then, there are others who take a look at Crystal River in Florida and find that concrete maybe only lasts tens of years. There are a lot of arguments that could be made.

CHAIR RYAN: Again, I think that is where, without trying to criticize or come up with an answer, it is really very site-specific.

MR. COCHRAN: It is --

CHAIR RYAN: The stylized approach may work at one place or some small number, but probably is not going to be useful at all. And I am just offering the suggestion that, if somebody comes up with a site-specific alternative to your stylized scenario, that that be allowed.

MR. COCHRAN: Okay, and the alternative approaches do.

CHAIR RYAN: I mean very explicitly in what you need to do and how you need to do it, so they get the guidance they need.

MR. COCHRAN: We even give very explicit guidance.

CHAIR RYAN: Okay. All right.

MR. COCHRAN: We really do -- if you have not had a chance to look ahead in the draft revised BTP.

Next slide.

After loss of knowledge, control, recognition, there is a public works project, maybe a regional pipeline, trenches through the landfill. The crew putting in the pipeline, they notice things are a little bit different, but they are behind schedule. The foreman urges them on.

Later, an individual -- maybe somebody out for a walk, maybe it is a worker -- finds a small source. It's small. It's old. It's interesting. And there is no indication of a hazard. It's just a piece of metal.

Next slide.

MR. WIDMAYER: Hey, John, before you leave --

MR. COCHRAN: Yes, sir?

MR. WIDMAYER: Where did this scenario come from in the context of Part 61?

MR. COCHRAN: This is not in 61. So, this is a scenario that is presented in the BTP that is, then, a basis for the encapsulation policy for gamma-emitting sources.

MR. WIDMAYER: So, I kind of don't understand. I mean, what --

MR. COCHRAN: Yes, it supplements Part 61. So, in 61, the developers envisioned one of two things happening.

MR. WIDMAYER: And this wasn't one of them.

MR. COCHRAN: That is correct.

MR. WIDMAYER: So, I am just kind of trying to understand where it came from.

MEMBER ARMIJO: So, it is introducing a new scenario.

MR. COCHRAN: That's correct.

MEMBER ARMIJO: Okay.

MR. COCHRAN: And it was driven, we understand from staff, that it was driven by the sealed-source accidents. And the staff said, "Boy, we didn't think about that in putting 61 together, that some of these small items might survive and also be unrecognized."

So, in developing 61, they envisioned that somebody would dig into a bunch of drums or waste and say, "Boy, this looks like a waste disposal site here. I'd better back away and investigate."

But, rather, there might be just a lot of soil, like you see in this photograph here, a lot of soil, and in it might be some little pieces of metal that might survive and still be dangerous.

MEMBER ARMIJO: But, so far, that still looks like a near-surface excavation, right?

CHAIR RYAN: Yes, that's 25 feet tops, that arm on it.

MR. COCHRAN: Something like that, yes.

CHAIR RYAN: So, I mean, they are not going to get to too much waste.

MR. COCHRAN: And let me just jump ahead. In the alternative approaches, one of the suggestions is that sources buried deeper than 10 meters might not be accessible, and it might be safe to bury larger sources. So, I am just going to jump ahead and tell you something that is in the alternative approaches.

So, the individual -- maybe it's a worker, maybe it's somebody out for a walk -- finds this interesting, old piece of metal in the soil, brings it home. It goes on a curio shelf.

And coming home, it is in their coat pocket for maybe four hours on the way home. It ends up on the curio shelf, where it is 2 meters from their couch where they sit maybe an hour a day.

And I would just point out on this curio shelf the majority of what is here are actually small, old pieces of metal. There's about 15 old pieces of metal on this curio shelf.

CHAIR RYAN: Staged for this presentation and photograph?

(Laughter.)

MEMBER ARMIJO: Well, this is your normal curio shelf, right? One of which is a cesium source, right?

MR. COCHRAN: And actually, it is my curio shelf. I am one of these guys who picks up small, interesting pieces of metal and arrowheads and rocks.

MS. RIDGE: I, however, have been cured of that practice.

(Laughter.)

MR. COCHRAN: Oh, you're not going to do that anymore?

MS. RIDGE: After this discussion, I'm not going to pick up little pieces of metal.

(Laughter.)

MR. WIDMAYER: After this, the digging scenario?

MS. RIDGE: Yes.

MR. COCHRAN: Next slide.

So, we then did a dose analysis to take a look at how big the source could be before the intruder saw 500 millirem. So, the exposure is in the pocket for four hours, coat pocket for four hours, then on a curio shelf five hours per week, 2 meters away.

And this may talk to your earlier point, Mike. It was surprising. Five hundred years, that's 16 half-lives. We found that the source has to be limited to 130 curies at the time of disposal to keep the dose under 500 millirem at 500 years.

So, the old rule of thumb may be good for dispersed radionuclides, but for concentrated radionuclides the rule of thumb doesn't hold up anymore.

MEMBER ARMIJO: But why wouldn't that be dependent on the depth of burial? A hundred and thirty was for 25 feet, a much larger number for 100 feet? It doesn't seem like it's --

MR. COCHRAN: In essence, we do as you recommend. Okay?

MEMBER ARMIJO: Okay.

MR. COCHRAN: Remember, philosophically, the BTP says it is generic, easy-to-use, lookup guidance for everybody.

MEMBER ARMIJO: Right. If it doesn't bother you, just do it that way.

MR. COCHRAN: That's right. And if you can meet the standards, be done. However, if you want to use the alternative approaches, here's some of our guidance.

And the guidance for sealed sources specifically calls out burial at depth greater than 10 meters might invalidate that exposure scenario because it would have to be a really deep trench to dig --

CHAIR RYAN: Well, it could be a borehole, too. I mean, there's lots of ways to do it. I would hope the guidance would be a little more explicit about how to look at alternative cases.

MR. COCHRAN: I mean, the guidance calls out 10 meters, and if it were disposed of in a long-lived source device, maybe titanium shielding, a blood irradiator with lead shielding, the intruder, even if it were excavated, can't put that in his pocket.

And it turns out that this exposure scenario, it's the in-the-pocket that mattered.

CHAIR RYAN: Sure. Of course.

MR. COCHRAN: On the shelf 2 meters away, a minor contributor.

CHAIR RYAN: He could swallow it, too, I guess.

MR. COCHRAN: Pardon?

CHAIR RYAN: He could swallow it, too.

(Laughter.)

MR. WIDMAYER: But that makes him an advertent intruder.

(Laughter.)

CHAIR RYAN: Yes, it does.

That is a longstanding question for me.

When is an advertent intruder --

MEMBER ABDEL-KHALIK: It is the normalization point. What would the result be if, instead of 500 years, it was 300 years?

MR. COCHRAN: I can answer the question. So, if you look at the table here, let's look at cesium. So, the Class C limit, the exposure was 500 years. And we have gone from 30 curies to 130 curies. The Class B limit, we did the calculation at 300 years. So, it is just under 1 curie at time of disposal. It will still give you 500 millirem at 10 half-lives.

Next slide.

MEMBER ABDEL-KHALIK: It just seems like it is all very arbitrary.

MEMBER ARMIJO: Yes, and I think it drives certain behaviors that may just not be practical or forces you; .72 curies, you know, I don't know how many sources -- that little thing the size of a quarter, what is the curie content in that thing?

MR. COCHRAN: You could certainly have tens of curies here of cesium chloride.

MEMBER ARMIJO: Right. So, where would somebody who wanted to meet the 300-year limit, would he have to actually chop that thing up and put it into smaller capsules, which doesn't sound like a good idea?

MR. COCHRAN: That is not a good idea with cesium chloride.

MEMBER ARMIJO: Yes, yes.

MR. COCHRAN: It turns out that most disposal facilities that are licensed for B are licensed for C. And so, you would be able to do the 500 years.

MEMBER ARMIJO: They would do the 500 years. And if they had lots of those little quarter-sized things that they needed to get rid of -- I am still trying to get to the point of a practical solution that still is safe. Is the depth of burial your solution? The obvious solution, that they have got a big site and they know as long as you don't get into the water table, and all that other related stuff, the accessibility just disappears.

MR. COCHRAN: Depth of barrel until you reach the greater than Class C limit. Then you need to shift regimes, if you will, and maybe not even dispose of it in the near surface at all.

The regulation defines near surface as 30 meters. That is near surface defined in the regulation.

So, we have got a new scenario basis. And, in turn, it was based on a reasonably foreseeable, and yet conservative, exposure scenario. Using the new scenario, we have got higher curie limits than what have existed since 1995, and we have got a transparent basis for using alternative approaches.

Because we understand the scenario that was used to develop the 130-curie limit, and so, as you have just said, the scenario assumes trenching goes through it. So, if I can go a lot deeper, greater than 10 meters, for example --

MEMBER ARMIJO: It doesn't apply.

MR. COCHRAN: -- it has probably invalidated the scenario.

Next slide.

MEMBER ABDEL-KHALIK: I mean, the fact that this is just totally arbitrary doesn't seem to bother you at all.

MR. COCHRAN: I have worked in this arena about 15 years. It might have seemed arbitrary 15 years ago, and it doesn't anymore. I mean, I understand the concept.

I also came out of a probabilistic risk assessment world, working on the disposal of transuranic waste. I did that for about a decade. And we do features, events, and processes, right, full FEPs analysis, come up with probability-weighted scenarios, but for inadvertent human intrusion.

MEMBER ABDEL-KHALIK: Could you just conceptually explain to me, why would a hypothetical intrusion scenario depend on the waste classification?

MR. COCHRAN: We took them independent. So, that scenario that you saw, we applied it to A, B, and C waste forms. I'm not sure I understand.

MS. RIDGE: I think I understand the question. It depends because the time of intrusion that you consider is different for different classes of waste.

MEMBER ABDEL-KHALIK: Right. Why would that be the --

MS. RIDGE: Because Class C waste is required to be disposed of with an intruder barrier that would prevent someone from intruding for 500 years. So, when we look at Class C, we assume, because the regulation requires it, that that intruder barrier is in place.

CHAIR RYAN: Just a point there, if I may, Christianne.

MS. RIDGE: Yes.

CHAIR RYAN: I think the intruder barrier is viewed to be doing different things to different practitioners. The intruder barrier to me is something that tells an intruder this is not Mother Nature; you are getting into something you probably ought to think about.

Is it the one that keeps him from getting a dose? Well, I'm not sure that is exactly right. If it is a reinforced concrete pad over a disposal cell that is -- pick a number -- 12 inches thick and has rebar in it, it is going to take an awful lot of work to get past it.

Somewhere in that process of attacking barriers has to make an inadvertent intruder recognize this is not Mother Nature.

MS. RIDGE: And that is assumed to be true for the first 500 years. And so, I think we are in agreement for 500 years.

CHAIR RYAN: Well, I mean, if we cut it off at 500 years plus one day, it is a different story. That I have a little trouble with because that could be true in some environments, not true in others.

MR. COCHRAN: The regulations almost have to work that way. You have got to draw some bright line, even though there is variability --

CHAIR RYAN: Well, that is not exactly true, either. We don't draw that bright line in a lot of areas in radiation protection.

MR. COCHRAN: Take speed limits, for example.

CHAIR RYAN: I don't want to go off into speed limits. Let's stick to our subject.

MR. COCHRAN: I like speed limits.

(Laughter.)

No, just kidding.

MEMBER SIEBER: He's from South Carolina.

CHAIR RYAN: I just find it a little -- I don't want to say "arbitrary" because I don't mean it is arbitrary. You have been very thoughtful in what you have done. But it is certainly deterministic, in my view.

MEMBER ARMIJO: And it is, and I don't have a problem with deterministic approaches if they make sense and you can use it as an engineer. You can say, okay, I can meet that criterion by doing this and this, and it is acceptable.

But it seems like that is more fruitful and less argumentative than getting into these things of what a hypothetical intruder will do 500 years in the future. And that is just for your Branch Technical Position, but other guys are going to try to apply, foresee what that person might do 20,000 years into the future, and that totally is bizarre.

So, it just seems like that inadvertent intruder thing is mucking-up a straightforward engineering judgment approach. These numbers may turn out to be the best numbers in the world. I don't have a problem with it. But it seems like we are going through this artificial process. It really just doesn't satisfy me.

MR. COCHRAN: If you could know the future, then you could put in the protective measures.

MEMBER ARMIJO: I don't need to know the future. I just need to know how dangerous this thing is, how small it is, and how I can make as inaccessible as possible. And I really don't think that one or two people 20,000 years into the future that might dig up something, it is beyond our responsibility to protect them. Okay? That's my personal opinion. And I don't think we are even in a position to do that.

If you just say, "Hey, look, we're going to bury these things and set limits so that, no matter how anybody got to them, they wouldn't get more than this level of exposure," and that's it. Forget the scenarios.

MR. COCHRAN: We have to have a scenario to set the limit.

MS. RIDGE: Well, I think that is essentially what we have done.

MEMBER ARMIJO: I don't know. I don't know. I'm a metallurgist, so I'm not a health radiation protection guy. But it just seems that this is a very difficult thing to understand.

MS. RIDGE: But I want to understand your point. I want to understand your point a little better because I am not sure exactly how that differs.

MEMBER ARMIJO: I may not have made a good point. So, that may be it.

MS. RIDGE: I mean, if you are willing to elaborate, when you say that, I believe you said you wanted to say, well, you're comfortable saying we just want to say, if someone is exposed to this, are we being protective, and let's not go through the artificial process of hypothesizing intruder scenarios. I don't know if I am paraphrasing you accurately, but that is what I heard.

And I am not sure I understand that because, when you say you want to be protective, if the person is doing what? If the person is exposed --

MEMBER ARMIJO: Only if he is doing normal, common activities. Okay? I will tell you where I saw this first that kind of struck me as strange.

In the Yucca Mountain analysis work, granted, that is spent-fuel, high-level waste, there were scenarios that I saw in some of the DOE documentation where somebody decides to put a drill right on top of the mountain, drill through a thousand feet of mountain, drill through a titanium drip shield, drill through an Alloy 22 container, drill through the stainless steel container, drill into the fuel, and then everything is released and it eventually all turns to rubble and contaminates the environment.

To me, that was so artificial -- I can show you the documents -- that I just lost total confidence in that analysis, so arbitrary, so unrealistic. And I see elements of that in low-level waste, which I just think it would be more practical to say, for cesium sources, if you want to get rid of a lot of it, you have got to bury it very deep, and this is the amount of maximum curies that you can bury. And that could just be a table.

MS. RIDGE: How would you arrive at that maximum amount?

MEMBER ARMIJO: I don't know how to do that, Christianne. I am just saying that is my kind of thinking.

And for stuff that is Class A stuff, blending and all these other things that you can do, it is not harmful.

MR. WIDMAYER: Presumably, it wouldn't be an inadvertent intruder scenario if you buried it deep, right?

MS. RIDGE: Right.

MR. WIDMAYER: Well, then, something else, some other scenario creates your limit then.

CHAIR RYAN: I kind of take out of this, because we could talk about inadvertent versus advertent intrusion for a long time --

MR. WIDMAYER: Yes.

CHAIR RYAN: -- much past the schedule for this meeting. I think if we just maybe take away the note that we are going to think about it, and hopefully you will think a little bit more about it, too, and we can take it up at a future meeting.

Somewhere along the line, I think Derek said it well. An inadvertent intruder is advertent --

and I'm not sure that is the same scenario. You know, if somebody decides they are going to set up a drill rig and drill 200 feet and do a borehole exploration, or whatever kind of really serious intrusion thing you want to do, I don't know how you stop that.

But, at some point, it is different than an inadvertent intrusion, where somebody accidentally intersects the waste in some way that results in exposure.

MS. RIDGE: To my mind, it is advertent if they know that there is a hazard there. It is inadvertent if you don't recognize the hazard. And to me, that is the difference.

CHAIR RYAN: But barriers to the waste create the opportunity to recognize this is something unique and different. And so, I guess I would offer you thought I think where we are stuck, or where I am stuck, is that at some point an inadvertent intruder becomes an advertent intruder.

MS. RIDGE: Class A waste --

CHAIR RYAN: So, a junkyard picker who picks up a source, to me, is a whole different ball game. And I did notice that all of your examples were from countries that might be viewed to be less sophisticated than what the average person that picked up those sources might be in terms of radioactive material and all the rest. So, I think it is important to have scenarios that guide us that are a little bit more realistic of what might happen at a well-engineered, well-operated, well-closed, funded by a closure fund that has got tens and hundreds of millions of dollars in it, with this ongoing monitoring and maintenance for at least 100 years, maybe longer, and certainly money to do that, different from somebody that scavenged. We need to come up with a little bit more realistic scenario to get as to what intrusion really might be like.

CONSULTANT FLACK: But if I could follow up on that a little bit, the more difficult you make it, the more difficult it is to get rid of, the more likely it is to end up with these other scenarios where they just don't want to be bothered getting rid of it because it is too difficult. And then, you increase the likelihood that it could be picked up, like these earlier scenarios, on the surface and expose a lot of people to this risk but not knowing it.

So, if you look at the holistic risk picture, right, the more you want to protect one, the more likely you end up exposing someone else to it.

So, I think there has to be a balance there somewhere.

MR. COCHRAN: And to reiterate what was said a couple of times, the limit that has been in place since 1995 is 30 curies. Now it is 130 curies and alternative approaches which didn't exist in the old BTP.

CONSULTANT FLACK: Right. So, it is trying to find that balance, is basically what you are saying.

MS. RIDGE: Moving in that direction, certainly.

MR. COCHRAN: Well, we've shifted.

CONSULTANT FLACK: Yes, it is just a matter of finding it, yes.

MR. COCHRAN: I know it is frustrating to you all. We are required to protect the inadvertent human intruder.

MEMBER ARMIJO: I know. You are constrained by the regulation. And I have read it, and it is so inclusive, "any and all", any inadvertent intruder for all, potential. It's ridiculous.

CHAIR RYAN: Well, I think what is the interesting part of all this discussion is that, while the rule and the regulation wording may not change, the way we are interpreting it has without changing the rule. So, maybe that is something to think about. I will think about it for sure. Maybe that is a construct that needs to be better explained fundamentally in the regulation.

MEMBER ARMIJO: The problem starts with the rule, the language in the rule.

CHAIR RYAN: I don't know.

MS. RIDGE: I would also like to point out that Class A waste is not required to be disposed of with an intruder barrier. So, when we talk about someone becoming an inadvertent intruder because surely they recognized the risk when they hit the reinforced concrete, that is not a requirement of the rule for Class A waste.

So, at least for that part of the discussion, I do think it is plausible that someone comes in, performing normal activities, building a dwelling, putting in a well, and they don't recognize the risk. It depends on where you are in the country, how common it is to drill into hard materials. And there are parts of the country where people blast water wells free of caliche. And certainly there are site-specific factors to be considered.

But I think that we should remember that we are not always, in some cases we are talking about places that would be reinforced with concrete, reinforced intruder barriers. But some of this waste isn't subject to that requirement. And so, we are trying to postulate scenarios that are based on activities that people perform today.

CHAIR RYAN: I think we have had a good discussion on this point --

MS. RIDGE: Yes, we have.

CHAIR RYAN: -- and I don't want to shortchange from the rest of your slides, which there are a few.

MR. COCHRAN: We're all but done. We're in the wrap-up, actually.

CHAIR RYAN: Okay.

CHAIR RYAN: Oh, we're not. Oh, my goodness. We have got to talk about a mixture --

(Laughter.)

CHAIR RYAN: I didn't think you were.

MS. RIDGE: Or we could skip that part.

(Laughter.)

MR. COCHRAN: Okay. So sorry. So, just the other half of my presentation I forgot about.

(Laughter.)

Okay. So, guidance on how to classify a mixture of individual items. So, what's this about?

Let's say I have got a drum, and in the drum I have got pieces of activated metal, different sizes, different curie contents. I want to know how to classify the mixture together inside the drum.

So, first, let me review what is in the 1995 BTP guidance. It actually offers separate guidance, depending on whether you got activated metal or contaminated materials or cartridge filters. Yet, the guidance is really similar. And one of the things we did in the revised BTP was just consolidate it.

The 1995 BTP and the revised, both define a couple of terms of art. One is primary gamma-emitters. These are cobalt-60, niobium-94, cesium-137. And if you look in the waste tables, Table 1 and Table 2, these are the only gamma-emitters that are there.

And then, also, the non-gamma-emitters, and those are defined in the BTP as well. You can read the list.

Next slide.

Still reviewing the 1995 BTP guidance, what it says is that you can classify this mixture of pieces based on the piece in the mixture with the highest classification. They call this a conservative classification. I just find the one in there that has got the highest classification, I apply it to the entire container, and I'm done.

Or you can also average across all the pieces, as long as you eliminate the hotspots. And there are two tests to eliminate gamma hotspots and two tests to eliminate non-gamma hotspots.

So, for the gamma hotspots, if it is very small, less than 1/100th of a cubic foot, and exceeds the Table A values for gamma-emitters, it should be taken out and managed separately because it is sealed-source-like.

There is a factor of 1.5 rule for the gamma-emitters. And what it says in the old BTP was that, for each of the primary gamma-emitters -- let's take cobalt or cesium, let's use cesium, actually -- the concentration of cesium in any individual piece can't be more than a factor of 1.5 times the average for cesium in the entire mixture. And it prevents deviations about the average.

Then, non-gamma hotspots, the non-gamma-emitters that are greater than Table B values should be removed and managed separately. And there is a factor-of-10 rule for the non-gammas. It is like the factor of 1.5, only it is for the non-gammas, and it is a factor of 10. So, the non-gammas in any individual piece can't be more than 10 times the average of that non-gamma nuclide.

Next slide.

So, this is the revised guidance for classifying mixture of individual items. It looks the same, but it is not. You do have the same general two choices to make early on. You can do the conservative classification or you can average across the mixture, curies divided by volume of the pieces.

There are still four tests, two for the gamma-emitters and two for the non-gamma-emitters. However, for the gamma-emitters, the Table A values have changed. I will go over those in a second. The factor of 1.5 rule is now a factor-of-2 rule, and it is interpreted differently.

For the non-gammas, the Table B is unchanged. And for the non-gammas, the factor-of-10 rule is still the factor-of-10 rule but interpreted differently. So, let me go through each of those real quick.

Next slide.

So, this test is to remove from the mixture items that are sealed-source-like. If any item in the mixture is less than 1/100th of a cubic foot and exceeds the Table A values, it needs to be pulled out and managed separately. Table A has been updated, and this is the same table as used for encapsulation of sealed source gamma-emitting. So, there is consistency between the encapsulation policy and the policy for disposing of items in a mixture.

Next slide.

At this point, let me go back and point out real quickly, for cobalt there is no limit because cobalt really does decay. It is a five-year half-life. It decays away pretty quickly. So, at 300 years, we ran the analysis with a Nordion irradiator pin, 14,000 curies in a single pin, 300 years it is still benign. It is still benign.

Next slide.

The factor-of-2 rule, this is based on a new exposure scenario. I'm sorry to say that to you. Based on a new exposure scenario that is very similar to the gamma-emitting, sealed-source, carry-away scenario except now the scenario involves larger pieces of activated metal.

And I've got some slides in the backup. We can go over that scenario, if there is time later.

Next slide.

Let me just go to the results. We started this with niobium-94, and we applied it to the others.

But the analysis demonstrates the need to protect the intruder from larger pieces of activated metal.

MEMBER ABDEL-KHALIK: Where did the 1.5 original multiplier come from?

MR. COCHRAN: It is described in the back of the 1995 BTP. It is a very brief description. It says that, should an intruder dig up pieces of activated metal in the landfill, and those pieces be reconfigured as a disk on the surface 3 meters in diameter, the dose would be 6 millirem per hour to the intruder at 1-meter distance. Therefore, a factor of 1.5.

So, at least in our revised draft BTP, if you read it, you will see that it is a lot clearer to understand and you could reproduce the calculations. But that is where it comes from. So, it is briefly described in a few sentences in the back of the 1995 BTP.

MEMBER ABDEL-KHALIK: But it is just another hypothetical scenario?

MR. COCHRAN: It is. It is.

So, what we found, looking at niobium-94 in activated metal was you have got to hold the concentration to less than two times the classification limit, keep the intruder dose under 500 millirem at 500 years, under the conditions described in the intruder scenario.

Next slide.

And I hope the next slide explains maybe the significant differences between the existing and the proposed.

CHAIR RYAN: John, just one quick question on that previous slide. I am going to ask it out of ignorance. How much niobium-94 is around in sealed sources?

MR. COCHRAN: Almost none. It is going to be in your activated metal.

CHAIR RYAN: Okay.

MR. COCHRAN: So, that table you saw -- go back, a couple more.

The niobium-94 is really here because we used the same table for pieces of activated metal as well as sealed sources.

CHAIR RYAN: Okay. All right. I understand now. Thanks.

MEMBER ARMIJO: Inactivated metal is the niobium? I mean, in stainless steel, is it chromium or what? Steel?

MR. COCHRAN: Yes, stainless.

MEMBER ARMIJO: Okay.

MR. COCHRAN: So, let's just look at the lower left. And what you see graphically -- it could be for any nuclide -- is the Class A, B, and C limits. And the bar represents the average for all the pieces in a mixture. So, in this case, the average is between the Class B and the Class C limit.

And you see the old factor of 1.5 is applied about the average. Okay? For niobium or cesium, you've got an average value. That is the bar. And then, for that nuclide, like cesium, it can't be more than 1.5 times above or below the average. So, that is the old one.

The new one, we have got the same mixture. You see the average is going to be in the same location. But what we found in doing the intruder exposure scenario analysis was you needed to keep the piece with the highest activity, no more than two times the Class C limit, to hold the intruder dose below 500 millirem.

Okay. Next slide.

So, there is a factor-of-10 rule for the non-gammas. It is really quite a bit like the factor-of-1.5 or the factor-of-2 rule in the other.

The old one was linked to the average. The new one is linked to the classification limit.

So, for each non-gamma nuclide, the concentration in an individual piece can't be more than 10 times the classification limit, as opposed to 10 times the average for that nuclide in the mixture of all the pieces.

Next slide.

So, in summarizing the revised BTP guidance for classifying a mixture of items, a mixture of pieces of activated metal, for example, you have a new Table A with higher gamma limits, a new factor of 2 which is linked to intruder exposure. There is no lower limit for the factor-of-2 rule like there was in the factor of 1.5. And it is linked to the classification limit, not to the average in the mixture.

We have also got a new factor-of-10 rule; basically, the same story. The factor of 10 linked to the classification limit and not the average in the mixture.

Next slide.

Now I am going to summarize the three topics that I have covered here.

Alternative approaches represents a new philosophy. The BTP provides uniform threshold or level of safety, easy-to-use, lookup guidance.

And then, through the alternative approaches, it gives guidance to the Agreement States and licensees on how they might deviate from the guidance.

Encapsulation, we have got a new scenario basis. We are not using the 2,360 hours of exposure anymore, but, rather, the gamma source carry-away scenario with the pipeline construction. This new scenario gives us new, higher curie limits, which means that more stranded sources can be disposed of with the new, higher curie limits. And we have also got a transparent basis for implementing the alternative approaches.

So, you understand the scenario basis, we gave you the 130-curie limit, and then you can now demonstrate why that scenario wouldn't be reasonable for your setting. Maybe deeper disposal or disposal in a sealed-source device where they couldn't take the source out.

Next slide.

This is just a summary slide on all the major changes to the BTP.

I don't know, Maurice, if you want to go through them.

MR. HEATH: No. Well, these are all the

ones that actually we have been talking about.

CHAIR RYAN: I don't think we need to read through them, unless anybody wants to look at them. We all have them here, and they are part of the record as well.

MEMBER ARMIJO: Okay.

CHAIR RYAN: But before we take questions, let me do something for the record. The Members in attendance today are Sam Armijo, Dennis Bley via telephone, Jack Sieber, and Said Abdel-Khalik. The Chairman is here as well.

Thank you very much. I'm sorry. I should have done that earlier.

Derek Widmayer is the Designated Federal Official for the meeting as well.

Thank you.

MR. WIDMAYER: You were supposed to that earlier, too.

CHAIR RYAN: I was.

(Laughter.)

Better late than never. It's on the record.

Any further questions?

Sam?

MEMBER ARMIJO: No, I have no questions.

CHAIR RYAN: Well, I am sure this is the first conversation we will have on this topic; I am looking forward to followup, but I think we have a lot to digest.

I'm sorry. No, he pointed to you like I was not paying attention.

MR. WIDMAYER: He wanted to make a comment potentially. He is on the agenda.

CHAIR RYAN: Oh, I'm sorry. Yes.

But we have a lot to do.

And, yes, I'm sorry. Drew, there you are. Path forward. Sorry, sir. My mistake. I can't see you behind Derek.

(Laughter.)

MR. PERSINKO: I just wanted you to finish your closing remarks there.

CHAIR RYAN: I was getting ready, but go ahead.

MR. PERSINKO: No, I just want to talk about path forward. Our plan for path forward was to brief the full Committee in December and then go out for public comment with the BTP in January, after we discuss with the full Committee.

We are also planning to have a public meeting on October 20th to discuss the BTP in

Albuquerque, and that is prior to going out for the official public comment. But we got it scheduled and on the agenda already.

CHAIR RYAN: So, we will have to work out having a letter at that meeting for you. So, I'm sure we will.

Thank you, Drew. I appreciate that schedule.

And just to be sure now, I understand you are going out in January to the public?

MR. PERSINKO: That's the plan.

CHAIR RYAN: Yes, that's the plan. Okay. Great.

Any other comments from Members? We're all set?

(No response.)

Anybody else? Any of the members from the audience?

(No response.)

Anybody on the phone, the bridge line, that would like to make a comment?

MR. MILLER: Can you hear me?

CHAIR RYAN: Yes.

MR. MILLER: I guess a couple of historical items.

CHAIR RYAN: Could you tell us who you are, please?

MR. MILLER: Clint Miller.

CHAIR RYAN: Okay.

MR. MILLER: Pacific Gas and Electric. I am the radwaste engineer at the Diablo Canyon Power Plant.

CHAIR RYAN: Okay.

MR. MILLER: There was a question about where the 1 cubic foot kind of came from as a potential hot item, and would that be a problem if somebody tried to hide that in other material. Historically, the 1 cubic foot is a default value for the size of a cartridge filter, which could be highly radioactive from a Pressurized Water Reactor.

In practice, it is very hard to hide anything over 1 r per hour in a shipping container of material that could be disposed of at lower cost, like rad trash. Because you are shipping in unshielded containers, you can't have the container over 1 r per hour unless you are in a closed van. So, that obviates that aspect. So, that is where the 1 cubic foot comes from.

Also, I appreciate the comments about encapsulation and why is there a criteria on the size of the container. Not so much for encapsulation of sources, but for encapsulations of filters and other objects, those very objects are often over 1 r per hour that we are trying to package and disposition appropriately. Encapsulation is often a path to be used.

And the NRC previously had received and approved the encapsulation of multiple filters in larger containers, much larger than a drum. And the key thing is, instead of having a size of a container, just go to waste-to-binder ratio. The 1 cubic foot is the size of a filter. There was a practical process of putting one cartridge filter in one 55-gallon drum. That is a 1-to-7 ratio or about a 14 percent waste-to-binder ratio for encapsulation of objects and cartridge filters.

We would appreciate it if that limit was not on a container for encapsulation of size, but, rather, just a waste-to-binder ratio. Anything over 14 percent loading in container of encapsulated mixtures, that should be seen as not diluting the waste and actually providing a more secure package for the environment.

CHAIR RYAN: Thank you. That is very helpful.

Just so I think everybody understands, there are two things in play, I believe, from your comments. One is how you meet disposal requirements, but you mentioned a couple of examples where it is not only disposal, it is transportation.

MR. MILLER: Correct.

CHAIR RYAN: So, you are mixing and matching, not mixing and matching, but you are trying to resolve two problems that are happening to you simultaneously. It has to be a legal transport unit, and then it has to be a legal disposal package. And sometimes those work well, and sometimes you have to work hard to make sure they are aligned. Is that correct?

MR. MILLER: Correct. One of your Committee Members, you know, "What's going to control someone or limit someone from trying to put something very highly radioactive into lower-activity material?" And the practical matter is the transportation limits are there.

MEMBER SIEBER: Yes, but there is shielding that you can put over, PICs, for example, to ship it.

MR. MILLER: But when you do that, but once you do that, sir, then you have already bought the price for the shipping cask. And that is looking at $5,000 to $50,000. So, once you are going to mobilize the cask to your site, you put everything you can into that high-activity shipment and make your most out of your money. You put all the hot stuff together.

CHAIR RYAN: I think that is a very important point, that there are practical transportation issues that licensees, particularly power plants with higher-activity materials in larger quantities, have to do to optimize their performance.

I guess I would think about that, if you have any written comments you would like to send in to the Committee on points that would be helpful for us to hear on what are your challenges as you see them under the BTP, I would welcome any input from the public on that point.

But I think you hit on an important point, that we, I think, have to be careful to make sure that whatever version of the new BTP ends up as the final also accommodates and recognizes these kinds of tradeoffs between the transportation requirements and disposal requirements and processing requirements, which is another dimension of all this. What is my limit of a process to make the waste acceptable to transport and disposal?

So, I would encourage you to send in written comments, if you would care to do so.

MR. MILLER: Yes, we are bundling those with NEI's and EPRI's comments to the NRC.

CHAIR RYAN: Great. We will look forward to having them. Thank you very much.

MR. MILLER: Appreciate it.

CHAIR RYAN: Is there anybody else on the phone that would like to make a comment?

(No response.)

MR. COCHRAN: Clint makes a good point. I mean, I have talked a lot about sealed sources because they are important. But you might encapsulate small pieces of activated metal or cartridge filters, as Clint just noted.

MR. MILLER: And oftentimes, high-activity valves are cut out of the plant, hot objects.

CHAIR RYAN: I think it is fair to say that sometimes the transportation requirements and disposal requirements drive the operational considerations for how to get those kinds of things done.

Any other comments? Is there anybody else on the bridge line that would like to make a comment?

(No response.)

Any final comments from our panelists? Maurice or Christianne or John?

MR. HEATH: I do have just one quick item. You mentioned it earlier, about the alternative approaches and having it well-explained and thought-out. And I just wanted to mention, as John said, it is actually in the BTP, in the revised. So, what we will do next time in the full Committee is we will just lay that out in the presentation, so you will understand. Because, like John said, there are provisions for having a different media for disposal, you know, if you wanted different shielding, titanium. Those things are in the BTP. We just might not have brought them across so they are explicitly known in this presentation, and we will do so in the full Committee.

CHAIR RYAN: Yes. Thank you. I think that will be helpful for the full Committee, to hear some of the insights you have relied on to end up with the revisions that you have made.

MR. HEATH: Okay.

CHAIR RYAN: That would be very helpful.

Christianne, anything else?

MS. RIDGE: No, thank you.

CHAIR RYAN: No? John? No?

MR. COCHRAN: It was a pleasure to be here.

CHAIR RYAN: As always, it was a pleasure to have you here.

And I want to compliment the staff and the rest of the team in radioactive waste management. They have done a lot of hard work trying to evaluate and divine and improve a document that is now quite old and has a lot of history behind it.

So, we will look forward to hearing further about it and then offering you our comments in a letter. But I want to appreciate your hard work and your talent that you have applied to this job. Thank you all very much.

MS. RIDGE: Thank you.

MR. COCHRAN: Thank you.

CHAIR RYAN: With that, hearing no other comments, we will adjourn the meeting.

Thank you very much.

(Whereupon, at 4:12 p.m., the meeting was adjourned.)

Advisory Committee on Reactor Safeguards

Review of Draft Branch Technical Position on Concentration Averaging and Encapsulation

Maurice Heath, Project Manager
Dr. Christianne Ridge, Sr. Systems Performance Analyst
John Cochran, Sandia National Laboratory

October 4, 2011

UNITED STATES NUCLEAR REGULATORY COMMISSION

Outline

- Introduction
- Technical Bases for Homogeneity Guidance
- Technical Bases for Alternative Approaches, Encapsulation, and Classifying Mixture of Items
- Summary

Topics Addressed

1. **Demonstrating homogeneity and classifying homogeneous waste**
2. **Classifying mixture of individual items:**
   - a. activated metals, or
   - b. contaminated materials, or
   - c. cartridge filters
3. **Encapsulation of sealed sources & other LLRW**
4. **Alternative Approaches**

Introduction

Maurice Heath
Project Manager
October 4, 2011

What is the BTP

- **Guidance document for waste generators and processors**

  - **classifying waste for disposal under 10 CFR Part 61**
  - **provides a method for averaging and classifying radionuclide concentrations in waste over a volume or mass of waste package**
  - **widely used by generators, processors and agreement state regulators**

10 CFR 61 Subpart C - Performance Objectives

- **Protection of the general population from releases of radioactivity.**
- **Protection of individuals from inadvertent intrusion**
- **Protection of individuals during operations**
- **Stability of the disposal site after closure**

10 CFR Part 61 Requirements Applicable to BTP

- § 61.42, "Protection of individuals from inadvertent intrusion"

- § 61.55, "Waste classification"
  - Tables 1 and 2 – define Class A, B, and C waste
  - § 61.55(a)(8)
    - ✓ Allows for concentration averaging in determining waste class

- 10 CFR Part 20, Appendix G

Waste Classification Table 2
10 CFR 61.55

Radionuclide	Concentration, Ci/m^3		
	Col. 1 (Class A limit)	Col. 2 (Class B limit)	Col. 3 (Class C limit)
Total of all radionuclides with < 5 yr half-life	700	n/a	n/a
H-3	40	n/a	n/a
Co-60	700	n/a	n/a
Ni-63	3.5	70	700
Ni-63 in activated metal	35	700	7000
Sr-90	0.04	150	7000
Cs-137	1	44	4600

If concentration does not exceed column 1, waste is Class A. If concentration is > col. 1 and < col. 2, waste is Class B. If concentration is > col. 2 and < col. 3, waste is Class C. If > col. 3, waste is not acceptable for near-surface disposal

Background

- Low-Level Waste Strategic Assessment, October 2007
  - Revisions to CA BTP – high priority
  - Risk-informed, performance-based

- Blending of LLW and SECY paper— CA BTP on hold

- SRM-SECY-10-0043
  - Risk-inform blending position in BTP

Risk-Informed, Performance-Based

- Risk-Informed:
  - Decision making approach that uses risk insights, engineering judgment, safety limits, and other factors.
  - For establishing requirements that focus on issues commensurate with their importance to public health and safety
- Performance-based:
  - Performance and results as the primary bases for decisionmaking
  - Performance-based regulations have these attributes, among others:
    1. measurable, calculable or objectively observable parameters exist or can be developed to monitor performance;
    2. objective, criteria exist or can be developed to assess performance;
    3. licensees have flexibility to determine how to meet the established performance criteria in ways that will encourage and reward improved outcomes

Risk-Informed, Performance-Based

- **Risk-informed**
  - Guidance linked to limiting doses to inadvertent intruder
  - Protection of inadvertent intruder 1 of 4 objectives of Part 61
  - Reasonably foreseeable scenarios
  - Evaluated consequences to intruder (500 mrem dose limit)
- **Performance-based**
  - Measurable parameters (concentrations of radionuclides)
  - Additional flexibility provided in revised version for alternative approaches, as long as intruder protection is maintained

Major Changes to 1995 BTP

Revised BTP	1995 BTP	Reason for change
Removed factor of 10 constraint for blending of wastes	Blended wastes subject to factor of 10 constraint	Consistent with Commission blending SRM
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Site-Specific Analysis Rulemaking and BTP

Activity	Intruder Protection ?	Primary user	Purpose
Site-specific analysis rulemaking	Yes	Disposal facility	Regulation
Concentration Averaging BTP	Yes	Generators and processors	Guidance

Technical Basis for Homogeneity Guidance in the Branch Technical Position on Concentration Averaging and Encapsulation

Dr. Christianne Ridge
Sr. Systems Performance Analyst
October 4, 2011

Waste Types

- Homogeneous materials
- Activated metals
- Cartridge filters
- Contaminated materials
- Sealed sources

Topics Addressed

1. Demonstrating homogeneity and classifying homogeneous waste
2. Classifying mixture of individual items:
   a. activated metals, or
   b. contaminated materials, or
   c. cartridge filters
3. Encapsulation of sealed sources & other LLRW
4. Alternative Approaches

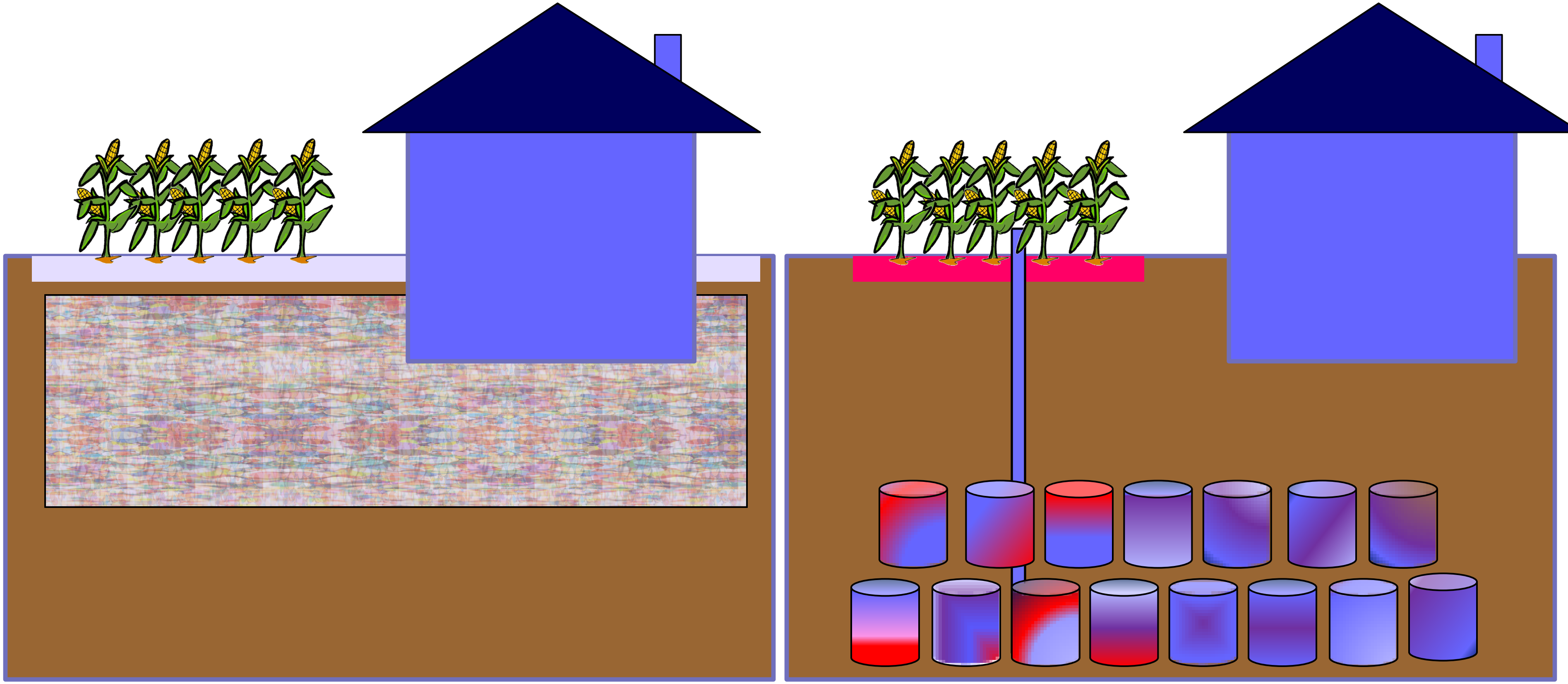
Homogeneity Guidance Topics

- Homogeneous Waste Types
- Intentional Blending During Waste Processing (i.e., “large-scale” blending)
- Classification of Homogeneous Waste

Reasons for Homogeneity Guidance

- Elimination of "factor of 10" constraint on inputs to a waste mixture
- Stakeholder concern
- Increased consideration of site-specific scenarios
- Commission direction (SRM-SECY-10-0043)

Alternate Conceptual Models



Part 61 Intrusion Analysis

Hypothetical Intrusion Scenario

Homogeneous Waste Types

- **Specific waste streams assumed to be homogeneous in the context of intrusion**
  - **Solidified or absorbed liquid, spent ion-exchange resins, filter media, evaporator bottom concentrates, ash, contaminated soil, and containerized dry active waste**

- **No homogeneity test proposed for designated homogeneous waste types**
  - **These wastes are homogeneous or easily mixed, or waste is expected to become easily mixed after 100 years**
  - **Waste classifiers advised to consider existing information**

Intentional Blending During Waste Processing

- Guidance based on dose to resident after a well is drilled on site
- Processors either demonstrate that process creates homogeneous waste or apply test to individual containers
- Homogeneous waste should not contain any pocket of waste larger than 1 cubic foot with a sum of fractions greater than 10

Classification of Homogeneous Waste

- More rigorous consideration of uncertainties recommended for waste with a sum of fractions close to 1
  - Consistent with 1983 Branch Technical Position

- Main sources of uncertainty expected to be
  - Spatial variability in radionuclide concentrations
  - Uncertainty in scaling factors

- Proposed Guidance: Sum of fractions should be less than 1 minus its standard error

Major Changes to 1995 BTP

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Technical Basis for Alternative Approaches, Encapsulation and Classifying Mixture of Individual Items in the Branch Technical Position on Concentration Averaging and Encapsulation

John R. Cochran
Sandia National Laboratories
October 4, 2011

UNITED STATES NUCLEAR REGULATORY COMMISSION

Topics Addressed

1. **Demonstrating homogeneity and classifying homogeneous waste**
2. **Classifying mixture of individual items:**
   a. activated metals, or
   b. contaminated materials, or
   c. cartridge filters
3. **Encapsulation of sealed sources & other LLRW**
4. **Alternative Approaches**

Roadmap

1. **Demonstrating homogeneity and classifying homogeneous waste**
2. **Classifying mixture of individual items:**
   a. activated metals, or
   b. contaminated materials, or
   c. cartridge filters
3. **Encapsulation of sealed sources & other LLRW**
4. **Alternative Approaches**

Alternative Approaches and Alternative Provisions

- **Alternative Provisions**
  - 1995 BTP - deviation from BTP guidance via deviation from Part 61 regulation (61.58), high bar for deviating from guidance
  - Revised draft BTP – Alternative Provisions restricted to deviations from Part 61 regulation
- **Alternative Approaches**
  - new section in BTP
  - deviations from BTP

Alternative Approaches

- **New philosophy:**
  - **BTP provides broadly applicable "look up" guidance & sets uniform level safety for implementing Agreement States**
  - **Alternative Approaches provides Licensees / Agreement States with *specific NRC guidance* on factors to consider in submitting / approving alternative guidance**
- **Example Alternative Approaches – BTP sets maximum curie limits gamma-emitters that can be encapsulated, and AA states that larger curie sources might be safe, if buried > 10 m deep in long-lived source device**
- **Provides intruder protection, with flexibility**

Roadmap

1. Demonstrating homogeneity and classifying homogeneous waste
2. Classifying mixture individual items:
   a. activated metals, or
   b. contaminated materials, or
   c. cartridge filters
3. Encapsulation of sealed sources & other LLRW
4. Alternative Approaches

Encapsulation of Sealed Sources and Other LLRW

- **What is encapsulation: Surround radioactive item (sealed source) in a binding matrix, in a container, where radioactivity remains in original dimensions**

- **Why it is good: waste form stability, worker protection, for classification average curies over entire volume or mass**

- **BTP sets limits on encapsulation to prevent use of extreme measures**

1995 Guidance: Encapsulation of Sealed Sources and Other LLRW

- Max. encapsulating volume or mass 0.2 m^3 or 500 kg
- Max. curie non-gammas: Class C limit when averaged across encapsulating media
- Max. curie gamma-emitters: based on exposure scenario in BTP

1995 Gamma Curie Limits for Encapsulated Items

- **1995 curie limits for gamma emitters based on intruder exposure scenario in 1995 BTP**
- **Limits based on scenario where intruder is exposed for 2,360 hours to encapsulated source 1 m from intruder**

Nuclide	For Waste Classified as Class A or B	For Waste Classified as Class C
Co-60	700 Ci	no limit
Nb-94	1 mCi	1 mCi
Cs-137/Ba-137m	3 mCi	30 Ci

Revised Draft Guidance: Encapsulation of Sealed Sources and Other LLRW

- **Maximum encapsulating volume or mass 0.2 m^3 or 500 kg - No Change**
- **Maximum non-gammas: Class C limit when averaged across of 0.2 m^3 encapsulating package - No Change**
- **Maximum gamma-emitter curie limits: new exposure scenario, with higher curie limits**
- **Alternative Approaches also available**

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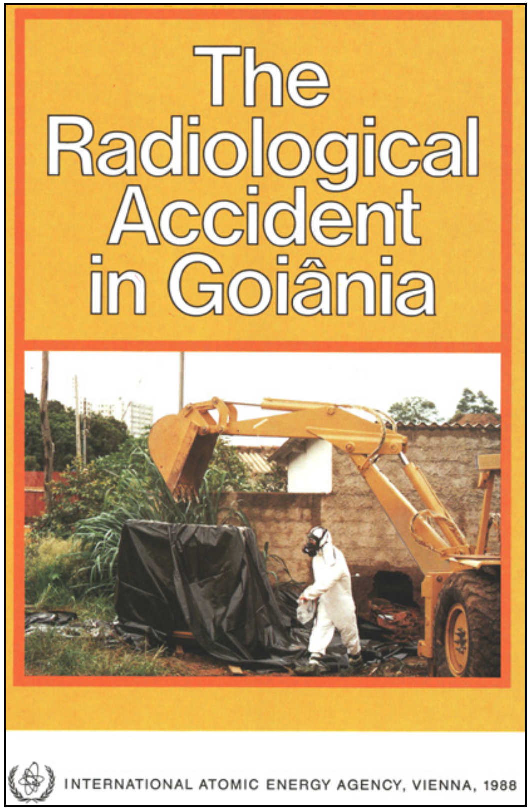
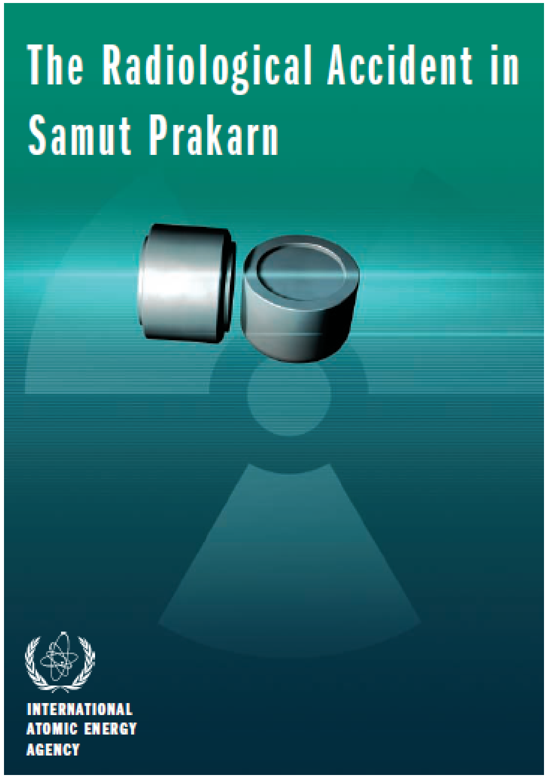
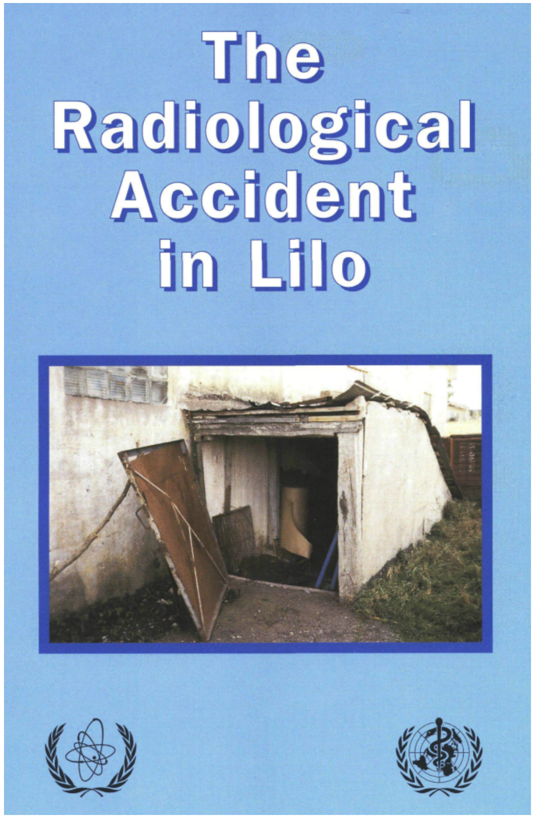
Development of Gamma-Emitting Sealed Source Carry-Away Scenario

- Accidents were a factor in developing new intruder sealed source scenario
- Considered sealed radioactive source accidents for inadvertent intruder discover of sealed radioactive source
- Developed “reasonably foreseeable, yet conservative” scenario

Reviewed Sealed Source Accidents







Reviewed Sealed Source Accidents

- **Common elements**
  - Loss of regulatory control
  - Victims engaged in normal activities
  - Radiological hazard not recognizable
  - Many accidents resulted in fatalities (adults and children)
  - Unlikely, but severe consequences

- **Many factors were considered in developing sealed source exposure scenario**

Gamma-Emitting Sealed Source Carry-Away Scenario

- **Not real, but stylized scenario used to ensure the intruder does not receive an inordinately high dose, should intrusion occur**

- **Scenario basics:**
  - **500 years after LLRW landfill closure, loss of control, recognition, knowledge**
  - **Containers / wastes / encapsulating media decayed**
  - **Stainless steel Cs-137 sealed radioactive source survived**

- Public works project, regional pipeline, trench through landfill
- Crew notices soil different, foreman urges crew keep working
- Individual finds sealed source: small, old, interesting
- No indication of a hazard

- **Individual takes home, 4 hours in coat pocket**
- **Curios shelf, 2 meters couch, 5 hours per week**

Results of Gamma-Emitting Sealed Source Carry-Away Scenario

- Analysis demonstrates need to protect intruder from small, highly-radioactive items
- Cs-137 sealed source ≤ 130 Ci at disposal, dose intruder ≤ 500 mrem at 500 years

Nuclide	Waste Classified as Class A	Waste Classified as Class B	Waste Classified as Class C
Co-60	140 Ci	No Limit.	No limit.
Nb-94	1 mCi	1 mCi	1 mCi
Cs-137/Ba- 137m	7.2 mCi	0.72 Ci	130 Ci

Summary: Revised Draft Encapsulation Guidance

- New scenario basis
- Reasonably foreseeable, yet conservative
- Higher curie limits – more stranded sources can be disposed
- Transparent basis for using Alternative Approaches

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Roadmap

1. **Demonstrating homogeneity and classifying homogeneous waste**
2. **Classifying mixture of individual items:**
   a. activated metals, or
   b. contaminated materials, or
   c. cartridge filters
3. **Encapsulation of sealed sources & other LLRW**
4. **Alternative Approaches**

1995 Guidance: Classifying Mixture Items

- **Mixture items: activated metals, *or* contaminated materials *or* cartridge filters *in single container***
- **Separate, but very similar guidance, for each waste type**
- **BTP defines "primary gamma emitters:" Co-60, Nb-94, and Cs-137/Ba-137m**
- **BTP also defines non-gammas emitters: H-3, C-14, Ni-59, Ni-63, and alpha-emitting TRU half-life > 5 years (except Pu-241 and Cm-242)**

1995 Guidance:
Classifying Mixture Items

A. Classify mixture using class. piece w/ highest class,
 or

B. Classify based on average of mixture, if hot spots are
 removed:

 Gamma hot spots:

1. Pieces < 0.01 ft^3 and > Table A gamma emitters
2. Factor 1.5 rule for pieces gamma emitters

Non-gamma hot spots:

1. Pieces > Table B for non-gamma pieces, any size
2. Factor 10 rule for non-gamma pieces

Revised Draft Guidance: Classifying Mixture Items

A. No change - Classify mixture using class. piece w/ highest class, or

B. No change - Classify based on average of mixture, if:

1. Change - Pieces < 0.01 ft^3 and > *Table A gamma emitters*
2. Change - *Factor 2 rule* for pieces gamma emitters
3. Pieces > Table B for non-gamma pieces, any size
4. Change - Factor 10 rule for non-gamma pieces

Revised Draft Guidance: Table A Updated

1. Pieces < 0.01 ft^3 and > Table A gamma emitters

- Updated Table A, which matches encapsulation values

Nuclide	Waste Classified as Class A	Waste Classified as Class B	Waste Classified as Class C
Co-60	140 Ci	No Limit.	No limit.
Nb-94	1 mCi	1 mCi	1 mCi
Cs-137/Ba- 137m	7.2 mCi	0.72 Ci	130 Ci

Revised Draft Guidance: Factor 2 Rule

2. Factor 2 Rule for pieces gamma emitters

- **New Rule is based on new exposure scenario, that is similar to Gamma-Emitting Sealed Source Carry-Away Scenario used to set the encapsulation limits for gamma emitters and the Table A limits**

Results of Gamma-Emitting Larger Items Carry-Away Scenario

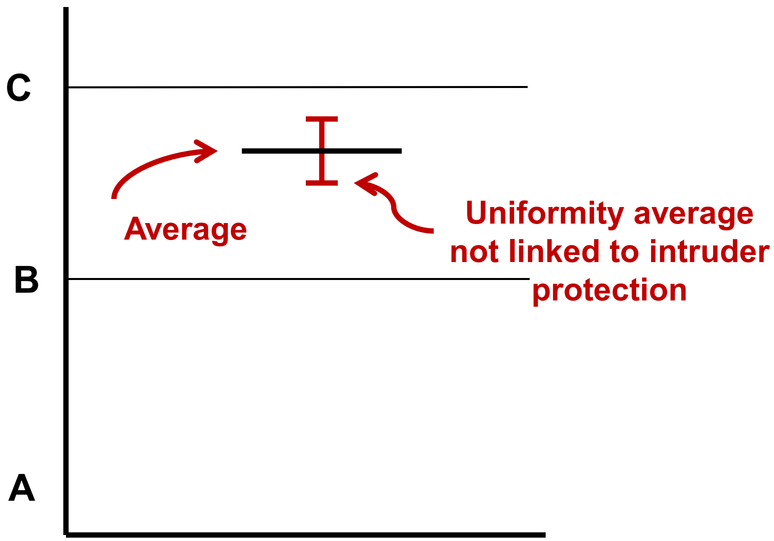
- **Analysis demonstrates need to protect intruder from larger pieces of activated metal**

- **Nb-94 (Co-60 & Cs-137) activity ≤ 2 x Class limit, dose intruder ≤500 mrem at 500 years (Factor 2 Rule)**

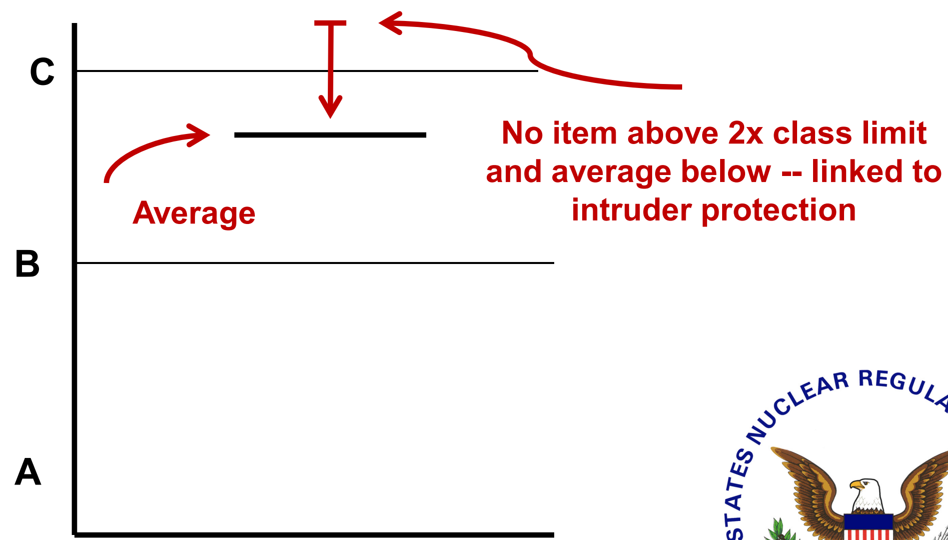
Revised Draft Guidance:
Factor of 2 vs Factor of 1.5

- **Current, concentrations of individual nuclides, in individual items < 1.5 X *of respective average of each nuclide in mixture***
- **Proposed, concentration in individual items < 2 X *of the class limit for that nuclide***

Factor of 1.5



Factor of 2



Revised Draft Guidance: Factor 10 Rule

4. Factor 10 rule for non-gamma pieces

- **Proposed Factor 10 Rule similar to proposed Factor 2**
- **Current Factor 10 relative to *average of each non-gamma nuclide in mixture***
- **Proposed, Factor 10 Rule relative to c*lass limit for that nuclide***

Summary: Revised Draft Guidance Classifying Mixture Items

- New Table A – higher limits gamma
- Factor 2 Rule gammas
  - New intruder scenario
  - No lower limit
  - Linked to class limit, not average of mixture
- Factor 10 Rule non-gammas
  - No lower limit
  - Linked to class limit, not average of mixture

Summary: Alternative Approaches and Encapsulation

- **Alternative Approaches**
  - New philosophy
  - BTP provides "look up" guidance, uniform level safety
  - AA provides specific guidance for deviations
- **Encapsulation:**
  - New scenario basis for gamma-emitter curie limits
  - Higher curie limits – more stranded sources disposed
  - Transparent basis for using Alternative Approaches

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