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(202) 234-4433

UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

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DISCRETE RADIOACTIVE PARTICLES PUBLIC WORKSHOP

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THURSDAY,

NOVEMBER 3, 2022

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The workshop convened via Videoconference, at 12:00 p.m. EDT, Sarah Lopas and Brett Klukan, NMSS, facilitating.

PRESENT:

ERIC DAROIS, Principal and Executive Director, Radiation Safety and Control Services, Inc.

DAVID M. HAMBY, Founder and Managing Partner, Renaissance Code Development, LLC

BRUCE MONTGOMERY, Director, Decommissioning and Used Fuel, Nuclear Energy Institute

SARAH ROBERTS, Senior Vice President of Radiological Programs, EnergySolutions

NRC STAFF:

CYNTHIA BARR, Senior Risk Analyst, Office of Nuclear Material Safety and Safeguards

GREG CHAPMAN, Senior Health Physicist, Office of Nuclear Material Safety and Safeguards

BRETT KLUKAN, Regional Counsel, Region I

SARAH LOPAS, Project Manager, Office of Nuclear Material Safety and Safeguards

JANE MARSHALL, Director, Division of Decommissioning, Uranium Recovery, and Waste Programs

CHRIS MCKENNEY, Branch Chief, Risk and Technical Analysis, Division of Decommissioning, Uranium Recovery, and Waste Programs

LEAH PARKS, Risk Analyst, Office of Nuclear Material Safety and Safeguards

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P R O C E E D I N G S

12:01 p.m.

MS. LOPAS: Alright. Good afternoon, everybody. Welcome to the U.S. Nuclear Regulatory Commission's public workshop on discrete radioactive particles.

My name is Sarah Lopas. I'm a project manager in the NRC's Office of Nuclear Material Safety and Safeguards, but I'm also an NRC meeting facilitator. So, that's what I'll be helping with today.

I also want to introduce Brett Klukan who, in his day job, is the NRC's Region I regional counsel, but Brett is also a facilitator and he's going to be helping me facilitate the virtual aspect, the Teams portion, of this meeting today.

So, a quick thank-you to Brett, because we do expect a decent amount of online participation today.

The NRC is holding this public workshop on the technical basis for development of interim staff guidance or communications related to survey and dose modeling approaches for discrete radioactive particles to support license termination.

So, the feedback the staff receives today

will be considered in determining the need for, and scope and content of, communications or interim staff guidance in this area.

So, to that end, I want to note that all the virtual meeting attendees and in-person attendees will have ample opportunity to ask questions of the NRC staff and make comments, and today's workshop is being transcribed by a court reporter, and the Teams meeting is being recorded as well.

So, both a transcript and a captioned video of today's workshop will be available at some point after the meeting on the NRC's public website.

So, in just a moment I will hand it over to NRC staff to get us started officially, but I just want to run through the logistics of today's workshop.

This is a hybrid meeting meaning that we have some folks here in the room with us today at the headquarters at NRC headquarters in Rockville, and then we also have, of course, people joining us online via Teams. Either they're using Microsoft Teams app or the web browser or they're dialing in to the Teams audio bridge line.

And I do want to note that if you have issues with Teams, it's always a good idea just to totally close out of Teams and rejoin the Teams

meeting. That's one way or use this bridge line.

Maybe jot it down quickly. You can always call in if for some reason your Teams is acting funny. And this bridge line is also in your registration information that you should have received as well. So, you'll be able to find it.

So, just a couple of notes. If you're here in the room, we talked about this already, you must speak into a microphone. So, remember to turn on your microphone before you speak.

So also for folks in the room, please remember to introduce yourself before you start talking.

That's so the court reporter knows who's speaking and that's how people on the Teams bridge line know who is speaking as well.

And then also for in-person attendees, our bathrooms are out the hall to the left. And if you need to leave the room quickly, just follow an NRC staff member, but there's lots of exits, of course, you can see.

If you're joining us via Teams, thank you. Everyone that is doing this remotely via Teams or the Teams bridge line, you have your microphones disabled for the moment.

And you'll see, on this slide, there is a rough agenda of today's workshop. So, when we get to the Q&A and discussion portions of the meeting, I'll be starting with questions and comments from the folks in the room. And then I'll be working with Brett to hear questions and comments from people who are joining us via Teams or the bridge line.

So, for the Teams folks, you're just going to go ahead and use that "raised hand" feature in Teams.

And then if you've called in via the bridge line, you're going to press *5. That will raise your hand. That will show us that your hand is raised. And then you'll press *6 on your phone once we indicate that you're ready to speak.

And just be careful if you've, like, double muted yourself. So, if you're calling on your cell phone and you also have muted yourself, you're going to need to unmute your cell phone and press *6.

We also have the chat -- the workshop -- so, the Teams meeting chat open today. So, those of you joining us virtually can send us shorter questions, shorter comments via chat.

We will have the NRC staff members monitoring the chat. Brett will be looking -- keeping

an eye on the chat as well so we can read some of those shorter questions and comments aloud, but try to keep those things short.

It gets a little bit cumbersome when people submit too long of questions or comments on chat. And you can also communicate via chat if you are having some technical issues with Teams.

So, to that extent, now I'm just going to hand it over to Jane Marshall, and Jane is the director of the Division of Decommissioning, Uranium Recovery and Waste Programs in the NRC's Office of Nuclear Material Safety and Safeguards.

Jane?

MS. MARSHALL: Thank you, Sarah.

I have the pleasure of welcoming all of you to our workshop on discrete radioactive particles. It's great to see so many people both in the room and online for this meeting today.

As Sarah mentioned, my name is Jane Marshall. I'm the director of the Division of Decommissioning, Uranium Recovery and Waste Programs in the Office of Nuclear Material Safety and Safeguards here at the U.S. Nuclear Regulatory Commission.

Today's meeting is part of a continuing

series of public meetings and workshops that we are holding on various topics of interest to our decommissioning licensees and stakeholders.

We have held two workshops on subsurface investigations -- one in July of last year and the second in May of this year -- and those were based on comments that we received on our consolidated decommissioning guidance -- also known as NUREG-1757 Volume 2, Revision 2 -- which was recently published in July of this year.

And that's calendar year, not federal fiscal year, because I know a lot of NRC employees and other federal employees look at it as 2023 already.

Please look into the chat. As Sarah mentioned, we have a chat feature. So, please look into the chat to find a link to that document. I find personally the links are way easier than pulling it out of ADAMS.

So, with regard to discrete radioactive particles -- or DRPs, as we call them for short -- I do want to stress that a good decommissioning program should have a program in place to control DRPs and that DRPs should not be an issue -- common issue at the time of final status survey.

Nonetheless, some of our stakeholders have

requested additional guidance on DRPs, which is the purpose of today's workshop.

We recognize the need for additional work in this area and we've contracted with Oak Ridge Associated Universities to review some of the survey techniques for DRPs and we've asked them to place extra attention on calculating scan minimum detectable activities for DRPs.

We've also contracted with Renaissance Code Development, or RCD, to review dosimetry for DRPs.

RCD developed dose conversion factors specific to DRPs and it's my understanding that they're going to be talking about those a little later in today's meeting.

I do appreciate the level of interest in decommissioning guidance development and enhancement particularly in the area of subsurface discrete radioactive particles and guidance for dealing with those.

NRC invests a significant amount of resources in developing technical guidance with the intent to show some acceptable methods for meeting NRC regulations to support consistency and quality of submittals and to make NRC reviews more timely and

efficient and transparent.

I appreciate your continued interest in our decommissioning guidance program and, in particular, the guidance that we'll be talking about today on DRPs, and I look forward to the discussion in today's meeting.

We will continue to work with you, all of our stakeholders, after this meeting to address technical challenges including survey and dosimetry considerations for DRPs and development of guidance.

To be kept informed of future activities and opportunities for participation with us, please see our "What's New in Decommissioning" website and we'll also put a link for that in the chat.

With that, I would like to thank each of you for your time and consideration today on this important topic and I will turn it back to Sarah Lopas.

Sarah, all yours.

MS. LOPAS: Alright. Thanks, Jane.

Next, I'm going to ask Bruce Montgomery from NEI to start us off with some opening remarks.

MR. MONTGOMERY: Yes. Thank you. I appreciate that, Jane, and appreciate being here with your staff to discuss this topic.

My name is Bruce Montgomery. I'm the director of Decommissioning and Used Fuel at NEI. I'm joined here on my left by Eric Darois of RSCS and Sarah Roberts of EnergySolutions.

It's still 2022 at NEI, Jane. So, thank you for that. I understand things are moving fast and forward, but I would really like to thank the NRC for holding this workshop and inviting NEI to participate in the discussion of discrete radioactive particles and how to treat them in the regulatory framework.

As you pointed out, this discussion really started back in 2021 as we were reviewing draft NUREG-1757 Volume 2, Rev 2, when we identified a couple of topics, significant gaps in the current framework for license termination for, as you mentioned, subsurface surveys and the other being today's topic of discrete radioactive particles.

We really appreciate the opportunity in the past to participate in the two workshops you mentioned on subsurface surveys.

With regard to discrete radioactive particles, we are optimistic that we can close the gap in the framework here and improve the efficiency of the license termination process and associated NRC reviews if we do a few things.

First, we need to align what the acceptable methods and tools are to perform scans and surveys for DRPs.

Second, we need guidance on the appropriate dose scenarios to use for DRPs and how to evaluate their health effects.

And finally, and maybe most importantly, by creating clarity around -- or we need to create clarity around the dose limits we are trying to achieve for each of those scenarios.

As you are aware, and as you mentioned, NEI is developing guidance for the commercial nuclear industry on the overall license termination process, we call it NEI 22-01, which we'll be submitting to NRC for review next month, and we feel that no guidance document is complete without a discussion of discrete radioactive particles.

From the materials provided in advance of this workshop, we can tell that the NRC is putting much effort to provide clarity in this area even as we are dealing with this issue during ongoing license termination activities at active decommissioning projects.

During the decommissioning process, which is destructive by nature, we should always take care

to minimize the spread of contamination beyond work areas while dismantling activities are occurring.

The industry believes that the best way to deal with this issue is to conduct our decontamination and dismantling activities in a manner that maximizes the control of contaminated material and minimizes the likelihood that DRPs remain at the site when major deconstruction and dismantling activities and remediation activities are complete.

NRC is encouraging the sharing of lessons learned in recent years across the decommissioning community in this area and will be capturing them for use by others going forward.

That said, despite best efforts it's reasonable to expect that we may encounter, as we have, DRPs during final status surveys in the future.

How we look for them, how we assess their impact on public health and safety are the questions of the day.

The industry believes that the questions we need to answer are in the following areas: No. 1, how and to what extent should final status surveys be aimed at detecting discrete radioactive particles? What are the acceptable survey strategies, tools and techniques? What are the criteria for detectability?

Second, what are the credible dose pathways?

Third, what assumptions should be made regarding particle sizes and, more importantly, solubility?

Fourth, for these pathways, what are the dose criteria that must be met?

Looking through the impressive body of work that the NRC has undertaken and completed in advance of this workshop, we can arrive at the following initial impressions:

First, there is at least one dose model of VARSKIN that benchmarks fairly well against established methods.

Second, there are existing and proven scanning methods that are known to be effective in detecting the particles of concern.

Third, the scenarios and likelihood through which an individual in the future may encounter a discrete radioactive particle can be postulated.

And finally, the health effects of discrete radioactive particles encountered through these scenarios are somewhat well-established -- are well-established.

From all this work, a couple of conclusions might be reached just by looking through the materials we will be discussing today.

First, as you indicate, the health effects from the exposure to a discrete radioactive particle generally begins in the range of 25 gray.

And second, the discrete radioactive particle that can deliver a dose of that magnitude is generally fairly easy to detect with existing instrumentation.

The premise behind these conclusions is that the risk-informed solution for the design of the regulatory framework around discrete radioactive particles should be within reach today.

We do offer a couple of recommendations. First, start with establishing a dose limit in the regulatory framework associated with skin dose to the public that would be attributed from a particle. Currently, 10 CFR 20 Subpart E does not have one.

Second, consider allowing the use of more advanced scanning technologies in the currently favored handheld two-by-two-inch sodium iodide detectors.

We believe there is great promise in detectability, precision, consistency and efficiency

particularly in the use of robotics.

We conclude our opening remarks by saying that the issue of discrete radioactive particles presents a great opportunity for the NRC to establish a risk-informed regulatory framework and there is a significant body of experience to draw from from the past with regard to DRPs that have been found prior to license termination, assess for significance and carefully and successfully dispositioned by the NRC at sites including Rancho Seco, Yankee Rowe, Connecticut Yankee and then following the Shelwell Services experience.

Finally, you've included a very interesting set of discussion questions in your package for today. They are very relevant and deserving of thought and discussion.

Given the short notice in seeing these meeting materials, I'm not sure we're prepared today to have the full discussion you desire on every topic.

You might want to consider a future opportunity to sit down and discuss these more completely. Thank you and this concludes my remarks.

MS. LOPAS: Okay. Thank you, Bruce.

Alright. Greg, I'm just going to pull up your slides. Just give me one moment.

Hang on. Let me -- I just have to share them via the Teams and I will get there.

Alright. Let's see. Now, we have Greg Chapman from the NRC who's going to give us an introduction to today's workshop.

MR. CHAPMAN: Thank you.

Hello. My name is Greg Chapman. I'm a senior health physicist in the Reactor Decommissioning Branch and I had the fortune this year of being assigned to a project site where DRPs are of concern.

So, today I'm just going to try to do kind of a high-level introductory of the topics into this DRP so you can kind of see what the NRC's concerns about it are.

And -- next slide, please. So, we'll start out with what exactly a DRP is. And even though "DRP" is kind of a new term, it's the same -- new term for the old term which was "hot particle" back in the '80s, '90s and 2000s.

And "hot particle" is defined as a discrete, high-specific activity radioactive particle less than 1 millimeter in any largest diameter -- or any large dimension, excuse me -- and is insoluble in water.

And we have quite a bit of guidance. Like

I said, this was originally thought up as a topic back in the '80s, '90s, 2000s and we have guidance, the industry has guidance, and it's been addressed pretty well up till now.

The pictures on the slide are of table salt. They're not particles, per se, but it's just there to give you some examples of a size for what we're talking about.

Most of what we're talking about is going to be in the range of 10 micrometers up to about 1,000 micrometers or 1 millimeter.

Next slide. So, DRPs and decommission are coming from a few sources. The neutron-activated metal, whether it's legacy wear products from when the reactor was operating and from the cooling systems and such, also cuttings from reactor vessel if it's segmented or the reactor vessel internals, or if there's rebar in the bioshield that gets cut up. This all could be a source of neutron-activated metal DRPs on the site.

There's also legacy fuel fleas and spent fuel that, again, come about during operations and are scattered throughout the cooling systems typically in the spent fuel pool and such and the neutron-activated bioshield concrete when the concrete gets cut up and

shipped off.

And there's also potential for others. Example, if there is any welding done with thoriated welding rods, that could be there. If there's any damage to some of the sources that might be in use, the smoke detectors or the neutron gauges, things like that. So, there's a lot of potential there for different materials to be in the present.

Next slide. So, our issues are first off understanding what the contamination events are and the risk of DRPs being released to the environment. Because if it's in the environment at the time of final status survey, that's what we're most concerned about.

The ability to scan for and identify DRPs on soil. The dosimetry associated with them and the potential exposures to the average member of the critical group. So, exposure scenarios.

And, as regulators, we're really concentrating on those last three questions there: What can be left behind, what's the risk of that material and what is acceptable?

Next slide. So, at the moment, our current regulatory requirements are, primarily for decommissioning, 10 CFR 20 subpart e and you see this

first bullet basically which is 25 millirem per year TEDE dose.

There are conditions to stretch it out to 100 millirem public dose limit. Again, this is TEDE dose. As notable, there are no deterministic effect limits for public in 10 CFR 20.

With that said, we do have some deterministic effect limits. 15 rem per year to lens of the eye, 50 rem per 10 centimeter squared shallow dose equivalent, and the 50 rem committed dose equivalent to an organ.

And basis for the internal exposure limits especially the committed dose equivalent, ICRP 26/30 biokinetic models.

The last bullet there is not really a regulatory requirement. I apologize for confusing the slide a little bit, but it's worth noting that the shallow dose equivalent that's in the 50 rem per 10 centimeter squared shallow dose equivalent rule for occupational workers is not a contributor to the TEDE dose there.

And so, if you're looking at potential shallow dose equivalent, how it applies for decommissioning becomes a bit of a tough fit. And so, it's a consideration we have to consider.

Also, for decommissioning and dose to the public we have averaging -- area averaging issues when you're looking at shallow dose equivalents.

And we're not quite certain whether 1 centimeter squared applies or 10 centimeter squared -- the current rulemaking at 10 centimeter squared, but prior to 2002 it was at 1 centimeter squared. And Dr. Hamby will go into the 1 centimeter squared for internal organs in a bit.

Next slide. So, if I go back a little bit and look at the 50 rem for 10 centimeter squared shallow dose equivalent, go back to the 2002 rulemaking there, they evaluated some of the risks that are associated with that.

And so, if I read some of the text here, which I've highlighted, they basically came back and said you can have up to 1,000 rem in a half-centimeter squared area. It will just have some dermal thinning.

And that was a risk that they felt was acceptable and even worst-case said if you had a fuel flea or a cobalt-60 particle of typically what they were considering at the time worst-case, it would result in a very small scab and those were acceptable risk for workers.

And you might be wondering why I'm

bringing up these worker dose limits or occupational dose limits, and that's because deterministic effects and thresholds, it's been said in the past, are applicable to everyone. So, they are protective of the workers. They should be protective of the public as well.

Next slide. I'm about to go a little bit into the internal dosimetry a little bit. And before I do, I just want to hit a couple of issues real quick.

If you go back to the ICRP 26/30 biokinetic models especially for an intake, through respiratory intakes, it will mention the 1 micron AMAD. And I just want to make sure it's apparent that AMAD is not what we're talking about when we're talking about a DRP.

Specifically, the "M" in AMAD stands for median. So, it's a distribution of material and the picture on the right is an example of what AMAD distribution would be. And the picture on the left kind of shows where particles tend to wind up in the respiratory tract based on their size.

And I believe I've previously said we'd probably go down to about a 10 micron aerodynamic diameter as far as looking at the smallest particle of

concern for a DRP. And while it can be lower than that, the size of the DRP really matters.

And assuming that the concentration of radioactivity in the particle is constant, then the larger the particle, the more radioactivity is present.

And if you look at the equation for a particle or sphere, it's 4/3rds pi r cubed, the "r cubed" piece of that means that the larger the particle it goes up significantly in activity.

And that's when we typically tend to concentrate on the higher-diameter particles and primarily in the nasopharyngeal region.

Next slide. I'm not going to go into detail on this, but I'm just wanting to point out that the models that are out there like the lung model or the next slide which is the alimentary tract or GI tract models, the way those are set up it has the biological transfer rates for them.

And if you saw them, they become differential equations. And basically even if you minimize the amount of solubility of the particles, it still shows a rate of movement through the body and through each compartment in the models.

And that is not indicative of what we're

really talking about when we're talking about an insoluble particle.

It basically has a residence time and then at plug flow goes into the next compartment for residence time, things like that.

And so, these models were not really applicable for DRP with one possible exception and that's with the fuel particles. So, spent fuel. And there's some evidence in literature that those are somewhat soluble in body fluids.

Next slide. So, next slide. So, if I look at the issues that we have with, first, getting exposures and how are we going to incorporate them into decommissioning, there are some things that are outside of 10 CFR 20. I especially want to talk to you about public dose exposures.

So, skin does if you're using VARSKIN, it comes out as the SDE. Or if you have ingested/inhalation of a insoluble particle, I'm calling it a local dose equivalent dose and that's using VARSKIN to get an SDE value, but SDE, shallow dose equivalent, is only defined for skin. So, it becomes a little bit of an issue.

Next slide. So, to resolve some of these issues that we have, considerations, as already has

been mentioned, we brought in RCD, and Dr. Hamby is here to talk about determining dose conversion factors for a limited group of radionuclides and hopefully it will make it a little bit easier for us to estimate potential exposures to DRPs.

Also, we have ORISE who is looking at scan MDAs versus scan MDCs, which is kind of a MARSSIM terminology, but MARSSIM is looking at areas of contamination as opposed to a DRP, which would be basically a point source.

And it's suspected that the work being done by ORISE will have some application with regards to discrete source materials and, in fact, will be in radium sites, things like that.

And also, there are draft reports that these groups are putting together for us. The ORISE report, I think, is attached to this meeting notice and we hope to have the draft report from RCD available soon.

Next slide. I apologize. My throat has tightened up on me. So, with that said, I've got some general considerations for DRPs and I think it's already been mentioned that for DRP management operating power plants had a system already in place and management program in place for DRPs and that

should be continued through decommissioning.

And if that is done properly, DRP should be controlled at the source and not released into the general environment.

However, if a release to the environment occurs, the licensee should take some corrective action to identify the extent of the release, do proper remediation of it, and document the surveys so they can support license termination later on.

Now, it's worth mentioning that the quicker these occur, the better to avoid secondary transport of the DRPs or even potentially mixing them with soil.

If DRPs are anticipated present in the environment, especially for license termination programs, it should be discussed up front in either the LTP or the decommissioning plan.

Next slide. So, these are a few of the past projects, they're not all inclusive, of some of the sites where DRPs were of concern in some manner and I just want to point out one of them particularly, that Shelwell is a very specific plant with different type of considerations.

It was not a reactor site and I think it had a cesium-137 source, and our general counsel has

been very firm in telling us that that was not a precedent-setting site.

The others, though, are reactor sites and to take that back up to kind of a one-mile-high look at them, typically the DRP levels of concern for these were 1 microcurie cobalt-60 source or less and the dose from that cobalt-60 source were anticipated to be less than 10 millirem.

And so, the whole issue was kind of resolved by doing a lot of adequate surveys. So, the licensee had to go back and do many surveys and make sure they had all the DRPs picked up and our corrective action -- or confirmatory surveys verified that.

So, the whole process is what we took to get regulatorily reasonable assurance that the sites were releasable.

And most commonly the methods that were used to do the surveys typically involved going at a 0.25 meter per second speed of survey and using a lower distance from the source for the detector.

Next slide. So, the NRC has -- is trying to actually come up with some methods and guidance for the acceptable dosimetry methods and scanning methods for DRPs.

The scanning methods we're hoping to put into NUREG-1507, 1757 Volume 2 and in MARSSIM. And we're also hoping early next year to have some generic communications which basically talk about preventing and documenting release of DRPs during decommissioning.

Next slide. And that's essentially it and I apologize for my throat getting a little bit tight there.

MS. LOPAS: That's alright, Greg.

So, I think at this point we are going to open it up for some questions before we move into the technical presentation.

So, we'll start here in the room. So, NEI, if you all would like to start first just remember, everybody, switch on your mics. Just say your name before you start talking for the court reporter. Thank you.

MR. MONTGOMERY: Yeah. Thanks, Greg. It's very informative and it goes to a lot of the questions and issues that I discussed in my opening remarks.

You mentioned Interim Staff Guidance and I presume the scope of that guidance would cover the topics you've discussed?

MR. CHAPMAN: On the guidance specifically that we're talking about putting into the NUREGs and to MARSSIM, we're particularly thinking of the scanning methodologies.

So, that's where we're really picking up on it at this point in time. One thing we can commit to.

We're debating amongst ourselves whether additional guidance is necessary since there's so much out there operationally.

MR. MONTGOMERY: Right. And you've covered pathways, dose limitations and limits in Part 20 and so forth.

So, would we expect to have to wait until NUREG-1757 Volume 2, Rev 3 comes out for that additional guidance or is there somehow we can achieve an agreement on what, you know, what our targets are going to be and how to get there some other way in advance of that.

MR. CHAPMAN: I would hope that we put out some interim guidance.

MR. MONTGOMERY: Okay. Thank you.

Yeah. I suspect there might be some questions on this side of the table, so I'm going to turn it over to my team.

MR. DAROIS: Thank you, Bruce. Thank you, Greg. Good job.

I just -- I want to go back -- you don't have to back up on your presentation, but conceptually go back to the historical profile where you mentioned the Yankee plants and Shelwell. I just want to comment on those.

I was there when those -- not Shelwell, but the Yankee decommissionings, I was there for -- when a lot of that had happened and a lot of the questions for DRPs came up.

And it's my recollection that the work that was done was to demonstrate that the existing, like, whatever methodology was being used would be adequate enough to detect particles rather than modifying any survey methodology.

In one case, I believe it was Yankee Rowe, the analysis showed that the ISOCS -- the use of ISOC system would be adequate to detect particles of a certain activity.

I don't know if it was 1 microcurie or 2, but it was some relatively low number, you know, and a dose assessment with that was done.

And a similar thing for Connecticut Yankee and for Maine Yankee. I don't remember all the

details, but I'm pretty sure that they didn't modify their survey methods.

Second, I understand for the Shelwell case the position is that that's not like a power plant. However, there's a lot of similarities and I don't think you can just wholesale ignore it because it's not a power plant.

It was deemed to be relatively insoluble cesium and it was in the form of particles and the survey method was done with a micro-R meter and it was shown to be adequate.

So, you know, we're dealing with, in some cases in the industry, particles that contain cesium that are relatively insoluble.

So, there's a lot of similarity. I wouldn't just discount it completely. That's just my opinion, but I'll leave it at that.

I do have a comment on the solubility issue on irradiated fuel, but I'll save it until Dr. Hamby's presentation.

MS. ROBERTS: Sarah Roberts, EnergySolutions.

I guess this is more of a question/comment that might be addressed in further presentations. So, I don't expect an answer right now, but it has to do

with the 25 millirem per year TEDE dose limit for unrestricted release of, you know, 25 millirem to a member of the public TEDE and clarification on how that would differ as far as discrete radioactive particles because discrete radioactive particles are not typically homogenous across the site, right? They're more limited -- they're a limited source term.

And you did mention that there are no deterministic dose limits currently for members of the public. So, just like some clarification on the difference, the distinction between the two.

And, again, maybe that will be discussed in later presentations, but that's my question.

MR. CHAPMAN: Can you clarify a little bit of what exactly is the difference between 25 millirem and --

MS. ROBERTS: Yes. Yes.

So, the current guidance, the MARSSIM, is utilized to demonstrate compliance with the 25 millirem per year TEDE. And so, there's a very specific guidance and statistical method to demonstrate compliance with that limit.

And for DRPs, which would be much more limited in nature just typically across the site, they would be -- it wouldn't be homogenous. They would be

just limited source term that would exist at a site.

So, it's not clear to me that the 25 millirem per year TEDE would be the proper dose limit for DRPs. So, that's a question/comment for further consideration.

MR. CHAPMAN: Okay. Thank you. We'll consider that.

MR. MONTGOMERY: Yeah, just to follow up on that, Bruce Montgomery again.

I think, you know, this goes to the question of what is the -- where is the source of the limitation? Is it occupational exposure, which would present, you know, if it's good enough for the workers, good enough for the public, that may be true. We just want to make sure we understand, you know, what you're going to be using, acceptance criteria in your reviews of the work we do especially in this area, discrete radioactive particles.

So, it's sort of going to the question of where we would see guidance appear.

MR. CHAPMAN: Yeah. There is -- we have not got any kind of definitive answer to that at this point in time, but there's certainly a probability issue associated with it as well as what the maximum dose could be.

MR. MONTGOMERY: Okay. Thank you.

And I guess you had mentioned during your presentation that license termination plan should have a discussion of discrete radioactive particles that they anticipate that they exist on site.

Should we assume that what you mean is that they're expected because of some operational history of the site?

And if we don't have that operational history, that we should simply not have that discussion, but simply use FSS, or final status surveys, to verify that the site meets objectives.

MR. CHAPMAN: Yes, exactly.

For instance, Connecticut Yankee did it up front in their LTP because they had a history of release. And so, it was addressed up front and they had criteria and stuff going into it.

If that's not the case, if you don't have the quality objectives for your surveys that appropriately, and so you might have to revise it and do license amendment at the last second.

MR. MONTGOMERY: Thank you.

MS. LOPAS: Okay. Brett, I know we have a couple questions in the chat I see that are coming up.

And Cynthia is answering some of them, but

I think, at this point, that I will turn it over to you to facilitate the folks online. Thank you.

MR. KLUKAN: Thanks.

So, again, for those of you who are participating virtually to ask a question at this time. If you're participating via a Teams app or a Teams browser, use the "raised hand" function. That will let me know that you would like to speak.

If you are participating via phone, please press *5. Again, that's *5. And then when I call on you based on your phone number, you'll have to hit *6 -- *6 to unmute yourself.

Before we begin, I just want to highlight, as Sarah mentioned, there are two questions in case others have similar questions both raised by Jan Boudart from NEIS.

The first being, could someone explain MARSSIM? And Cynthia Barr gave an explanation of what MARSSIM represents, the Multiagency Survey and Site Investigation Manual, and provided a link to that.

And also, what techniques have been developed for preventing DRP, discrete radioactive particles?

And Cynthia provided a response to that indicating that additional information will be

forthcoming at the conclusion -- or after the conclusion of the workshop today.

So, with no further ado, we'll turn to those who have raised their hand and the first is Paul Blanch.

I am going to allow your mic at this time. Whenever you're ready, please feel free to unmute yourself and begin your question.

So, whenever you're ready, Mr. Blanch, feel free to unmute yourself. Click on the little microphone icon at the top of the screen and begin your question. I've unmuted you on our end.

Hi. It looks like we may be having some problems, Mr. Blanch, because we're not hearing you. You might want to try dropping off the meeting and then joining back in again.

If you have further technical difficulties, please put them in chat or you can try joining via the bridge line that was put up on the screen earlier.

So, while you're figuring that out, we're going to turn to our next speaker, Michel Lee. I'm going to unmute you.

And so whenever you're ready, please feel free to unmute yourself and begin your comment.

MS. LEE: Hi. Can you hear me?

MR. KLUKAN: Yes, we can hear you.

MS. LEE: Okay. Perfect. Yes, the -- I think just as an administrative thing, I think it would be good to put up the phone number for folks again maybe periodically throughout the meeting since it's a long meeting and people might be joining.

But anyway, my questions are related to two things -- or my points relate to two things. So, one, I -- I mean, through a parameter of common sense the operational history of a site would seem to be really, really critical in determining how carefully and extensively a survey instrument, you know, surveys are done.

I can give you an example of Indian Point. In the state where I am in New York, we have a very long history of spills and leaks and so forth at the site and other problems.

So, I think it's really imperative to make sure that records are kept, that exiting employees are interviewed so that you can capture their institutional knowledge, and that the NRC personnel review the site history in their own systems to be able to possibly spot areas. So, that's No. 1.

No. 2 really relates to the public health

issue. When it's stated that it's not clear that 25 millirem TEDE is a proper source term to the DRPs, but there's an assumption that terms for workers would protect the public, that just simply does not comport with the last 50 years of medical science unless you're having, you know, little girl toddlers as workers at your site, you know.

It's a big difference in the vulnerability of different populations both by gender, by age. So, I really would hope the NRC would start to incorporate those considerations. And I'll put myself back on mute.

MR. KLUKAN: Well, thank you for your questions and comments.

MS. LOPAS: Okay. Brett, do we see anybody else with their hand raised?

MR. KLUKAN: Sarah, not at this time. Again, Mr. Blanch, it seems like you may have dropped off.

We can -- it would be nice if we could see your right now. But if you -- I'm not seeing you. Hopefully you'll be able to rejoin -- or he'll be able to rejoin and we will catch him during the next open session.

So, alright, not at this time, Sarah.

Back to you.

MS. LOPAS: Okay. And do we have any chats that came in that we want to read aloud?

MR. KLUKAN: Yes. So, we have two. I think these relate more to the comment section, so -- but I'll read them now since we have them.

Steven Rademacher wrote, one possible discrete particle scenario which is not common to the nuclear reactor industry, but is related to a number of sites worldwide, are discrete plutonium particles. This should be considered as well.

Thank you, Steven, for your comment. The other comment we received was from Don Mayer.

It is not true that the 50 rad limit in Part 20 was informed by the TEDE limit consideration during rulemaking.

The supporting information indicated TEDE was not a risk to be concerned with at the 50 rad-to-skin dose.

Thank you, Mr. Mayer, for your comments. We have -- looks like, Mr. Blanch, you have rejoined us. I'm going to try to unmute you at this time.

So, Mr. Blanch, again, try to hit the microphone on your Teams app. It looks like you've unmuted yourself, so please feel free whenever you're

ready.

MR. BLANCH: Okay. Can you hear me now?

MR. KLUKAN: Absolutely. Yes.

MR. BLANCH: Fantastic.

I've been involved in decommissioning in a lot of plants, Indian Point, Maine Yankee, Connecticut Yankee, Vermont Yankee and SONGS and somewhat on Zion, and the question I have -- I understand that most of the requirements for unrestricted release in Part 20 is based on dose or dose rate.

My question has -- and a lot of these plants, and especially Indian Point, which Michel Lee was talking about, are talking about repurposing the site.

Now, repurposing the site could be, you know, another power plant. It could be condos. It could be unrestricted.

My very specific question doesn't have to do with dose rate, but it has to do with the number of Curies or activity that is allowed to be covered up at a site that is released for unrestricted use.

I've been through the regulations. I cannot find anything and I'm aware that there are some very high activity levels at some decommissioning plants. And I believe Maine Yankee and Connecticut

Yankee have pipes that are quite active -- radioactive.

What are the limits -- and I'm not talking about small particle sizes. I'm talking about what are the limits in specific activity for release -- unrestricted release at a decommissioned site that will permit unrestricted reuse of that site?

And that would include, again, condos, parking lots, occupancy below ground and so on and so forth.

Who can provide me a specific answer to that question?

MS. BARR: This is Cynthia Barr at NRC.

We don't have an activity limit our regulation specifies a dose limit of 25 millirem per year to the average member of the critical group that's total effective dose equivalent, but you raise a good question specific to discrete radioactive particles.

And we're actually going to have some presentations in the technical portion and have some discussion questions that I think tackle the types of things that you're looking for. Do we need to have separate limits for discrete radioactive particles?

So, if we could table that question to

after the technical presentations and then talk about it more under the discussion period, that might be a little bit better so we can hear from our contractor, specifically Dr. Hamby from Renaissance Code Development.

MR. BLANCH: This is an extremely important question and the public has the right to know for repurposing a decommissioned site, you know.

If they're going to dig, are they going to dig up highly radioactive components including discrete particles?

And it's a question that I believe needs to be answered before any site receives an unrestricted use.

I mean, I don't want to have to dig down and, you know, hit 5 Curies of cobalt-60 or, you know, strontium-90 and so on and so forth.

And for all the people like Michel and others that are involved directly with Indian Point, this is a vital question and it needs to be answered, and it needs to be answered with a very, very high priority and the public needs to know what is underneath a decommissioning site be it Zion -- I know at Connecticut Yankee I've had a lot of contact with those people. There's a lot of strontium down there.

The NRC needs to address that particular issue.

Maybe this isn't the proper forum, but it's a high priority and people have the right to know what is buried and what is the activity and the dose rate should those become unburied.

Everyone here is assuming that site is not ever dug up again. So, I'll leave it with that. If anyone wants to respond, I'd appreciate it.

MS. BARR: Yeah. No, those are very good points, Paul, and I think Chris wants to say something, too, but our dose standard is, as I said, 25 millirem per year total affected dose equivalent. And it would include assessing the risk associated with buried materials or subsurface material.

In fact, we are developing guidance very specific to that topic and we've had two workshops related to that topic.

So, if you're talking about buried material, they do have to consider various scenarios that could uncover that buried material, bring it to the surface where a member of the public can be exposed.

So, we have a very, you know, we have a regulatory framework in place and we have established guidance that says acceptable methods on how you can

show what you leave behind is acceptable with respect to meeting that dose standard.

But today's topic is on discrete radioactive particles and they're a little bit different and we're going to get into some more details on why they can't really be treated the same way as other distributed radioactivity.

And so, I just wanted to table that particular portion of it until after our contractor presentations where they're going to explain some of the differences between discrete radioactive particles and distributed particles, but Chris would like to say -- okay. I think I covered what Chris was going to say.

And so, Paul, we appreciate the comment, we think you're absolutely correct and hopefully we'll be addressing that. So thank you again for your comment.

MR. KLUKAN: Thank you again. We're going to have to move on here in a second.

Jan, I do see that you put in two comments. We'll get back to those when we get to the discussion portion. I don't want to -- I'm not forgetting about them. I just think those are better brought up there.

And then, Boby, it looks like you raised your hand to add something to this. So, if you wanted to chime in now, and then after Boby we'll move forward.

So, Boby, you should be able to unmute yourself.

MR. ABU-EID: Yes. Thank you.

Can you hear me now?

MR. KLUKAN: Yes. Yes, we can.

MR. ABU-EID: Yes, sorry. Just want to mention that Paul Blanch has a point. It's definitely we use exposure scenario in order to assess the dose whether it's coming from discrete particles or coming from somewhere else.

The reason is because there will be a time factor, what is the time of exposure, what is the pathway, what kind of activity.

So, we do that in order to assess the dose impact; therefore, for each specific site it maybe the licensee that could select exposure scenario and will review the exposure scenario and then we could put the dose impact. The major thing is the dose factors or dose discrete particle through inhalation. And for the skin dose is something else. We can deal with it through our codes.

So, these are the main things that I really -- that I'd like to talk about. I agree with Paul. This is very important to us. There is actually the exposure scenario and the pathways and the time for exposure. Thank you.

MR. KLUKAN: Alright. Thank you, Boby.

And with that, Sarah, I will turn it back over to you.

MS. LOPAS: Okay. I am going to pull up Nick Altic's slides. Nick is from Oak Ridge and he's going to start us off with a technical presentation.

So, just bear with me for a moment while I get these up and running here and I share them on Teams for everybody.

Alright, Nick. You have been made a presenter. So, whenever you can see the slides, you can get started, Nick.

MR. ALTIC: Great. Could you please confirm that you can hear me?

MS. LOPAS: We can.

MR. ALTIC: Great. Great. Thank you for the introduction.

And so, today I'm going to present on the topic of how we might estimate the scan minimum detectable activity for discrete radioactive particle

under a kind of traditional MARSSIM-like gamma walkover survey.

Next slide, please. So, I mean, the primary objective of this presentation is to dissect the calculation method into the various steps and then step through that calculation and see how the resulting scan MDCs compare under the different evaluation conditions that we performed.

And as we move through the presentation, we'll see more about how the MCNP and MicroShield codes come into play.

Next slide. So, just to start with a little bit of background as, you know, MARSSIM practitioners are probably all aware how the traditional scan minimum detectable concentration plays an integral role in the final status survey design and planning.

We know that this is a sensitive component of the FSS design and it can drive our sample size that we need for the statistical assessment in a Class 1 survey event.

And it's also an important concept from a planning aspect to provide insurance that our surveys are sensitive enough to detect hotspots of concern on the front end.

So, NUREG-1507 provides calculation guidance on how we might estimate these, you know, more traditional scan minimum detectable concentrations.

So, the scan MDC calculations presented in NUREG-1507 are more for volumetric contamination at least as they apply to open land area surveys.

I mean, you will recall the hypothetical hotspot evaluated in NUREG-1507 as sort of a cylindrical volume of contamination.

Next slide. So, we make this sort of implicit assumption when we implement the NUREG-1507 approach, is that the detector response is uniform across the assumed source and/or the observation interval. And we'll talk a bit more about that in later slides.

And that's due to the assumption of a constant exposure rate across the source; however, this isn't really the case due to edge effects where the exposure rate can decrease close to the edge of the source.

So, we may be able to live with that for this assumption of volumetric contamination, but it becomes much more difficult to live with this assumption for a constant detector response for DRPs

because of the point source-like response where you have a sharp peak response where the detector is directly above the source, and then the response decreases as kind of a 1 over r squared relationship.

So, in practice, when the surveyor is moving along, you know, they hear an audio blip from the rate meter output.

And so, the previous discussion kind of highlights the need for an alternate approach where we need to assess an instrument response that corresponds to this increased audio output that the surveyor would hear from the meter.

Next slide. So, here we have a summary of the calculation approach. So, in general, we follow the methodology laid out in NUREG-1507 except that we need to modify the estimation of the detector response in a manner that corresponds with the aforementioned audio blip.

So, as previously discussed, the traditional 1507 approach assumes the detector response is constant.

And so, that's something that, you know, we're going to correct for, you know, using this modified approach.

So, here in this -- the summary of the

calculation method, we've dissected this process into five steps.

So, we first need to determine the detector response in an XYZ coordinate system. Then if we understand how the detector response, meaning the efficiency of the detector to the source as a function of distance from the source, we can estimate the response at each XYZ coordinate.

Once we know the response at each coordinate, we can then integrate the response over some period that would correspond to the audio increase and output from the rate meter.

And then finally, we can estimate the scan MDA using a slightly modified equation from NUREG-1507.

Next slide. So, during our traditional gamma walkover survey, we have no guarantee that the detector will pass directly over the particle.

So, therefore, when we think about calculating scan MDAs, it's probably more appropriate to think about the calculated results in terms of a histogram or some probability distribution.

And so, I mean, for this study we kind of wanted to bound that distribution; therefore, estimate the, you know, what the scan MDA might be under, you

know, best-case and worst-case scenarios.

So, this slide presents all the various conditions that we have evaluated. So, in terms of radionuclides, we've looked at cobalt-60, cesium-137, thorium-232 and americium-241.

We wanted kind of a high, medium and low sampling of photon energy. And thorium-232 might seem kind of like an oddball, but, however, we know that these can take place in the field likely due to welding rods.

So, we evaluated the scan MDA at a few different surveyor velocities; 0.25, 0.5 and 1 meters per second.

And then we also looked at how the scan MDC is impacted by the ground-to-detector distance or how close the probe is to the surface soil.

And then also a very important point, we looked at how the scan MDA is influenced by various particle depths.

So, we -- for the four radionuclides, we evaluated the scan MDA to particles present at the surface, at 7.5 centimeters in depth and 15 centimeters in depth.

So, we also increased this depth component to 30 centimeters specifically for cobalt-60 and

cesium-137.

And finally, we wanted to consider a couple DRP positions, you know, that would evaluate this worst-case and best-case scenario.

So, we considered the position when the detector passes directly over the DRP. We're calling this the "optimistic scenario," and when the detector DRP does not pass over the DRP, or the "pessimistic scenario."

And we have some illustrations to help kind of show these best-case and worst-case scenarios in the next slide.

So, next slide, please. So, as mentioned previously, the first step in our modified calculation approach is to establish detector positions on an XYZ coordinate system.

So, consider that the surveyor is standing in the plus-C direction, so coming out of the screen here, and walking along the positive-Y axis with some velocity.

So, as the surveyor walks in the positive-Y direction, they're moving the detector in a flat, serpentine motion, which this side-to-side motion is captured in the positive and minus-X direction of our coordinate system.

And so, we're making the simplifying assumption that the ground-to-detector distance is constant.

So, our conceptual model of this surveyor transect simplifies the two dimensions of the X-dimension and Y-dimension.

So, in order to model the serpentine motion of the detector, we used a sine curve. And then, so we generated 200 equally spaced points along the sine curve for which we subsequently evaluated detector response.

So, here in our plots for both the optimistic and pessimistic scenario, the DRP is indicated by the red dot.

So, you can see under the optimistic scenario the surveyor has the detector passed directly on top of the source. And in the pessimistic scenario the DRP is maximally located from the serpentine motion of the detector.

And so, these plots sort of represent a snip of a surveyor's transect during a gamma walkover survey.

So, and the -- because the surveyor is traveling with some velocity, you know, that introduces a temporal component to detector position.

So, for this analysis we assume that at -- time-T equals zero occurs at the coordinate location negative 0.5 meters and negative 1 meter.

Next slide, please. So, in order to estimate the detector response at each position on the sine curve, we need to understand how -- detector efficiency as a function of distance from the source.

So, in order to accomplish this, we used MCNP, which is Monte Carlo N-Particle Transport code, to estimate detector efficiency at varying offsets from the DRP.

So, the MCNP results were scored using the F8 tally, which is the detector pulse height tally which basically just counts the number of occurrences that happen in the user-defined energy bin inside the detector.

So here, this graphic kind of depicts our -- the model of our detector at MCNP and the -- for the various efficiency evaluations we basically varied the offset of the DRP with -- relative to the detector.

And I should mention that for this evaluation we only considered a two-inch-by-two-inch sodium iodide detector.

In terms of the MCNP results, the tally

errors were generally less than 10 percent and we achieved good statistics for a majority of the problems.

There was one exception and that's with americium-241. Because of the low energy gamma associated with this radionuclide we're only presenting results for the surface.

So, we were unable to get the MCNP problems to converge, you know, for the DRPs at the various depth.

Next slide, please. So, we used the MCNP results to construct an efficiency curve, which is presented here in the left-hand -- or right-hand side of the screen.

And so, once we have the discrete data points, we want to be able to fit a continuous curve to the data and we fitted these efficiency data to a log-logistic function using R.

And so, the plot shown is specifically for cobalt-60. So, here on the Y-axis we have the detector efficiency in terms of counts per K, and on the X-axis we have the offset of the DRP from the detector.

And so, here each facet represents the ground-to-detector distance that we evaluated, you

know, on the left-hand facet we have a 10-centimeter ground-to-detector distance. And the right-hand facet depicts the efficiency curves for the 7-1/2-centimeter ground-to-detector distance.

And these curves kind of follow our intuition, right? As we hold the detector closer to the source, we get a stronger response.

And the fit of the log-logistic function is described by the equation at the bottom of the slide.

Next slide, please. So, this slide is primarily for any MCNP users that may be in the audience.

This, you know, the discussion on this slide doesn't affect the results, but I thought it would be worthwhile to dedicate at least a slide to the workflow of the MCNP simulations because we did evaluate approximately 600 MCNP runs and preparation and extraction of data from these MCNP files can be quite tedious.

Therefore, we employed Python to generate the various input decks based on a template. So, we would use Python to vary these, you know, because we're only varying one or two parameters in each MCNP run. So, it's more of a variation on a theme. So, we

used Python to sort of automate this process for us.

And so, in terms of the data extraction, starting with version 6.2 of MCNP, ships with some utilities called MCNP tools.

And within this toolset is the MCTAL utility which allows us to incorporate this utility into our Python extraction code, which we were able to extract the tally information from the MCNP input decks -- or from the MCNP output files.

And additionally, we had this Python script check the results in terms of the relative tally error and whether or not we were passing all of MCNP's statistical checks.

And, you know, when we ran the script, we would get input decks that didn't meet certain quality criteria and were flagged for additional evaluation and/or were reran.

Next slide, please. So, just as a -- because as we'll see, as we step through the calculations, so much is dependent on the efficiency curve, we wanted to have a little bit of some empirical data to sort of backup the MCNP calculations.

So, here we have a plot of efficiency curves calculated by MCNP, which are represented by

the blue line compared with some experimental data that we generated using a two-by-two-inch sodium iodide detector in our lab. And just as a general overall, we see that the two curves follow similar trends.

So, we collected the experimental results by using, as I said, a two-by-two-inch sodium iodide detector relative to a cobalt-60 source.

And as with the MCNP simulations, we collected these empirical sodium iodide measurements of 5-centimeter offset intervals and then we calculated the real-world efficiency based on source activity.

So, in general, I already remarked on the shape of the two curves. There are some limitations with the experimental dataset.

Unfortunately, we were only able to use the tools that we had available to us. So, some of these limitations include -- the cobalt-60 source that we had isn't exactly this traceable, which impacts the accuracy and precision of our efficiency calculation.

The experimental data were collected with a single sodium iodide detector. And we know that not all sodium iodide detectors respond the same depending on the condition of the crystal and/or age of the

instrument.

And the experiment was performed with the detector placed on a workbench, which is not necessarily the same as the soil conditions we evaluated in MCNP, but, nevertheless, we get fairly close results.

Next slide, please. So, once we know the efficiency, we can formulate an equation that describes the detector response as a function of offset. And here, this general equation is depicted on the slide.

So, as we mentioned, we've already established that our detector positions are going to follow a sine curve. So, really it just -- we simplify this equation into one dimension, which is time. And so, we can plot the sodium iodide relative response per microcurie of DRP as a function of time in our small, little snip of the surveyor transect.

I just want to call attention to this equation right here. This activity term represented by "A" kind of slipped its way in there by mistake.

So, this would -- you would multiply by the activity if you wanted a sort of absolute response for a specific activity level, but for this calculation we're interested in a normalized response

in units of cpm per microcuries.

So, this "A" term was added -- is in there by mistake and we'll be looking to correct that in our revised version of our report.

Next slide, please. So, this is -- this graphic illustrates the relationship between the response at each location on our sine curve and the response curve we presented on the previous slide.

So, this is -- this sort of graphic is specific to the optimistic scenario, and you can see our response function peaks at the location where the detector is closest to the DRP, which follows our intuition.

Next slide, please. The next, we need to develop a response that corresponds to that audible blip we mentioned that's identified by the surveyor.

So, when we looked at this, we assumed that the area -- the total integrated area under the main peak in the previous response data corresponds to this audible response.

So, at this point, we've established our detector locations. So, we now know the distance from the DRP to each point on the sine curve.

And, as such, we can simply -- we can simplify the top integrand in this general equation

and only integrate with respect to time and, fortunately, we don't need to fit the response data to continuous equation depicted on the previous slide.

We can approximate the area of the curve by subdividing the peak area into a small number of trapezoids, calculate the area of each and summing the result.

So, one thing to note is that the maximum peak width may change slightly depending on the location of the DRP. We saw that in the previous slide under the optimistic and pessimistic scenario. The width of the maximum peak is slightly different between the two scenarios.

And because we set this real for ourselves where we're only going to take credit and integrate over the maximum peak, this introduces kind of a dynamic observation interval which is unlike the traditional NUREG-1507 approach where we take an observation interval based on that reflects our surveyor technique.

Next slide, please. So, let's take a look at the optimistic scenario to understand how we define this dynamic observation interval and integrate the response curve.

So, if we look at -- so, we were going to

integrate over the peak response. So, we set the midpoint of the peak at the maximum response and integrate from the minimum response of that peak to the maximum response. And so, here the X-axis is time, so our observation interval is simply the Tmax minus Tmin.

So, recall that for the pessimistic scenario we had two gaussian-like peaks. So, under this methodology we're only integrating over the maximum peak.

So, in other words, we aren't taking credit for the surveyor hearing the two audio blips, which is conservative for this analysis.

Next slide, please. So, after we've determined and integrated detector response, we can use a slightly reformatted equation from NUREG-1507.

The MDCR is no longer applicable as we've integrated the response over a -- our defined observation interval.

So, the MDCR in the NUREG-1507 equation is replaced by this MDCT term, which is the minimum detectable counts, in our observation interval.

So, the other only notable difference of this equation, when compared to the equation in 1507, is that by using MCNP we're calculating the sodium

iodide detector response directly.

So, we don't have to go through that messy conversion using the cpm per becquerel per hour conversion coefficient. And of course the d-prime and surveyor efficiency values are determined by our project DQOs.

So, over here on the right-hand side of the screen you can see the defaults we used for these calculations, d-prime, and then our index to sensitivity we selected 1.64.

And I guess in this case we're arguing for a lower d-prime because when we go out and we implement our survey, we're going to pause, literally, and really do a large number of secondary investigations. In other words, we're going to accept a lot of false positives in our survey. And then the surveyor efficiency we're using here is 0.5.

Next slide, please. So, putting it all together, you know, the previous steps, we get the following plot of results.

I know this plot is a little busy, but I do think it provides a good summary of all the various radionuclides and conditions we evaluated. So, we do have -- we do have -- the results are tabulated and presented in our report.

But just to kind of explain this plot, so on the columns of each plot are represented are ground-to-detector distance.

So, we have 10 centimeters on the left here and 7.5 centimeters on the right. And the horizontal facets represent the various radionuclides we evaluated.

And then the color corresponds to the assumed DRP depth in soil. And then the shading of each color represents the scenario whereby the lighter shading represents our optimistic scenario and the darker shading represents the pessimistic scenario.

So, as I mentioned, the actual numbers aren't necessarily important for this presentation. We do provide those in the write-up.

Rather, I just -- I wanted to focus across the various trends we evaluated, but I will just make a general remark on the magnitude of the results.

And, in general, the calculated scan MDAs are on the order of tenths of microcuries under optimistic conditions, and on the order of a few microcuries for pessimistic conditions.

And when we look at this plot, we can see that the results are, for the most part, consistent with our intuition.

As the surveyor speed decreases, the scan MDC -- or scan MDA decreases as well. As the particle depth increases, the scan MDA increases.

And, I mean, we can see that the scan MDA is optimized when the detector passes directly over the top of the source, which makes sense.

I need to be a little bit careful here, you know. As the old saying goes, the plural of "anecdote" is not "data," but these numbers do generally align with some of the DRP activities that we've identified in the field.

I guess more so on the lower end we haven't found, you know, numerous DRPs at the nanocurie level. They're -- what we're consistently finding are on the order of a few tenths of microcurie.

So, there is one point that may not necessarily be obvious about this plot that maybe it doesn't follow our intuition, which we'll discuss more on the next slide, please.

So, the scan MDAs or ground-to-detector distance of 10 centimeters are slightly lower than the corresponding 7.5 centimeter ground-to-detector distance values under the pessimistic scenario and when the DRPs are present at depth.

So, there's a couple causes that may explain this scenario. And one is that under the pessimistic conditions, the detector responses are primarily calculated based on the tail of the efficiency curve where the fit is not quite as good as the lower offset values; however, it seems more likely that the second piece right here is the cause of this difference.

So, when the detector is held closer to the ground and the DRP distance is at depth, we have a slightly more level of soil attenuation from the gammas, as indicated by this sort of figure to the right.

And, I mean, it is interesting to note when you look at the raw efficiency data from -- generated by MCNP, the efficiency values for the 10 centimeter ground-to-detector distance and when the DRP is at depth are higher than the corresponding values of the 7.5 centimeter ground-to-detector distance.

Next slide, please. So, MCNP may not be available to all MARSSIM practitioners. It is a controlled code.

So, you can't just go out and purchase this off the shelf. You have to request access

through the Oak Ridge RSICC office.

So, we wanted to reperform part of the analysis for a limited number of conditions using MicroShield.

So, we evaluated a subset of conditions, two radionuclides, cobalt-60 and cesium-137, we looked at both ground-to-detector distances of 7.5 centimeters and 10 centimeters, and we -- this evaluation was performed at a surveyor velocity of 0.5 meters per second and, again, we considered the optimistic and pessimistic scenario.

And, really, the only way that -- or the only time MicroShield sort of creeps into this analysis is that we're using MicroShield to develop the efficiency curve rather than using MCNP. Otherwise, the calculation steps are the same.

And so, next slide, please. So, I mean, here is a similar plot for the MicroShield results. It's a much simpler plot because we didn't evaluate all the conditions that we did using MCNP.

So, I mean, the results show a similar trend to those that I talked about, you know, in the previous MCNP results discussion.

If we move on to the next slide, please, what's probably more interesting is how the

MicroShield analysis compare with the MCNP results.

So, here we have a multifacet plot that compares the ratio of MicroShield results to MCNP results.

And, as indicated by the plots, MicroShield, I guess, overestimates the scan MDA, which is conservative for all conditions except for one, which is the pessimistic scenario, when the DRP is located on the surface.

And moving on, next slide, please. So, I guess, in conclusion, in general, we achieved the lowest scan MDAs when the detector is positioned closest to the ground, the surveyor maintains a slow, forward velocity, and the DRP is positioned on the surface.

So, we evaluated surveyor velocity at 0.25 meters per second, which, you know, might not necessarily be achievable in real-world settings, you know.

Various surface terrains may prevent the surveyor from progressing this slowly; however, we could maybe optimize our design and have a set of scan MDAs where we would use the -- we would apply the slower surveyor velocity for maybe a follow-up investigation.

Probably it's not surprising that the thickness of the soil cover greatly influences scan MDA and, you know, as such, the DRP investigation survey should occur whenever you have the best chance of finding the DRP, so before they -- any site activities that could distribute these DRPs into deeper soil strata.

And at least from the conditions we evaluated, MicroShield is, you know, seems to be a reasonable alternative for MCNP just in terms of the efficiency curve generation.

And, I mean, we didn't -- we were only able to look at a subset of conditions and radionuclides, you know. Expanding this work, we could look at the impact of collimating sodium iodide detector and how that influences the scan MDA.

I should just back up just for a moment and mention that we selected MCNP because -- for this evaluation because we wanted the flexibility of adding a collimator perhaps at a later date. And that is the end of my prepared talk. So, I --

MS. LOPAS: Thank you, Nick.

I think what's going to happen is we're going to move to our next technical presentation, we'll have a break at 2:00 p.m. for 15 minutes, we

have one final technical presentation, and then we're going to open it up for discussion and more questions.

So, if everybody can hold their questions, I know there have been some -- there's been some activity in the chat as well. That's okay, too, but hang on one second. I'm going to -- yep, I'm going to put the references up. Sorry about that, Nick.

Okay. Yep, here are the references. Alright. I'm going to cue up Leah Parks from NRC in just a moment.

Leah, just give me a moment to pull myself together and get everything shared correctly.

I am very slow at this. Almost there. Alright. As long as you can see the slides, Leah, you are all set.

MS. PARKS: We can see the slides.

Can you hear me?

MS. LOPAS: Yes, we can.

MS. PARKS: Okay. Great.

Again, my name is Leah Parks. I'm a risk analyst in our Risk and Technical Analysis Branch within DUWP and today I'm going to be covering -- I hope to cover Point 3 and Point 4 that Bruce brought up in his opening remarks, which I felt were a very good summary of some of the issues that we want to

discuss in this workshop.

So, for a quick overview of our slides, the slides for today -- next slide, Sarah. Thank you -- I'll be talking about the release criteria that we do have in our regulations right now, which is the 25 millirem TEDE.

And I'll be talking about how we define the critical group and the potential exposure groups as well as the steps in performing a dose assessment and what exposure pathways are typical, how we eliminate pathways and consideration of likelihood.

And so, I'm going to go over how we typically do things and then I'll also pose some questions for what does this mean for DRPs.

Next slide. Thank you. So, we have unrestricted release criteria in 20.1402 subpart e. Some key concepts in this statement -- I'm not going to read it for you all. You all can read it -- are that the dose is received above background level, that it is a TEDE, as everyone has pointed out on numerous times -- on numerous occasions so far, that it is a dose to an individual, not a collective population, and it's an individual of an average member of a critical group.

This dose is also for any one-year period

within the compliance time frame and it includes groundwater, and also the residual radioactivity must be reduced to ALARA in addition to meeting the 25 millirem criteria.

So, the way that licensees show compliance with the 20.1402 criteria is to perform surveys according to 20.1501. And those surveys evaluate the magnitude and extent of radiation levels, as well as the concentrations and the potential hazards that those radiation levels might pose.

So, 20.1402 references this average member of the critical group. So, let's hone in on that in the next slide.

Okay. So, what is the critical group, first. The critical group is a group of individuals that are reasonably expected to receive the greatest exposure to residual radioactivity for any applicable set of circumstances.

So, in defining this group, we look at their habits like how much time they spend outside versus inside or onsite versus offsite, their actions as well as their characteristics like inhalation rate or soil ingestion rate.

Next slide. So, who is the average member of this critical group? According to draft NUREG-

1549, the average member of the critical group is an individual who, in turn, is assumed to represent the most likely exposure situation based on prudently conservative exposure assumptions and parameter values within the model calculations.

Next slide. Alright. So, to perform -- sorry, this still has some animation left in it. You can just scroll through the -- go back. Okay. I lost my text for some reason there. It's okay.

To perform a dose assessment, you first define your site conceptual model, which includes identifying the contamination source -- so, that's your radioactive signal there -- and how it moves through the environment to a receptor.

So, this conceptual model helps you determine the appropriate exposure scenario. So, the next -- yeah, go to that slide, the conceptual model slide. Yeah.

So, this is a graphic that illustrates a typical conceptual model for the resident farmer scenario, and then we also have a fish pathway there, too.

In general, each exposure scenario should address where is the residual radioactivity, how does the residual radioactivity move through the

environment, and where or how can a human be exposed?

So, for DRPs, what does this mean? The site conceptual model would include information about where the DRPs are located on the site that is to be released, how many there are potentially present, and how humans could be exposed to them.

Next slide. So, part of the dose assessment is defining your source configuration or your contamination source.

And when you define this, you consider the following questions: What radionuclides are present? In what media are they present? For soil -- for example, soil or water, etcetera. What is the physical and chemical form of the contaminated media expected at the time of release? What is the area and depth of the residual radioactivity? How are the radionuclides expected to be distributed in the contaminated media?

So, in this slide in the top visual graphic there we have -- this is just a figure taken out of the RESRAD user manual that shows the diffuse contamination as a layer of soil underneath a cover where people are walking around at the site.

The bottom picture is a picture of a discrete radioactive particle. Actually, I think

there are two on that piece of tape.

And because the configuration source is so different for these two types of sources -- or the contamination configuration is so different, typical DCGLs are not useful and typical MARSSIM approach is also limited.

Next slide. Okay. So, how the contamination source is encountered by the receptor depends on the exposure scenario.

These are some examples of exposure groups that fall under different exposure scenarios and here you'll see what we usually fall on for unrestricted release, which is a bounding scenario for resident farmer, but that's not used in every single case.

Next slide. Again, so how does this translate to DRPs at an unrestricted release site? So, for DRPs, the exposed groups could potentially be anyone who's living in the area, using it for recreational use or working in the area. And this exposed group may also include a child.

The behavior and dietary habits of children might become important for DRPs because they spend a different amount of time digging in the sand or the dirt and they also might have a higher likelihood of inadvertent ingestion of sand or soil.

So, the habits and activities for a group might include walking potentially barefoot. And if the release area is near a beach or a body of water, additional activities may include beach combing, sunbathing, playing and paddling or swimming.

And once the exposed groups are defined, the exposure pathways for those groups can then be explored by further defining their habits, actions and characteristics as well as the characteristics of the source.

Next slide. Okay. This slide lists some of the potential exposure pathways and it's presented for discussion and not intended to imply that a licensee must include all of these exposure pathways.

So, we have external pathways and we have internal pathways. External pathways include, you know, if you're just standing nearby or if a particle gets trapped under your fingernail or it could get into somebody's eye.

It also could be in your clothing where it's near to your skin, but not touching your skin for some period of time. And, therefore, there might be prolonged exposure if it, you know, stays in your shoe for some period of time.

We also have inhalation and ingestion.

And it's important to note that, which has been brought up previously in this workshop, that the cancer risk may not always be the most important risk here.

We might be looking at threshold effects that are more important than cancer risk for DRPs and, therefore, it's important to also consider what those threshold doses -- what those doses are for the deterministic effects.

Alright. Next slide. Okay. So, this table describes the framework for considering probability scenarios as it's laid out in our guidance NUREG-1757 Volume 2, Revision 2.

So, after consideration of potential scenarios, the licensee presents its chosen compliance exposure scenario. So, this might be a screening scenario, a bounding scenario or a reasonably foreseeable scenario.

And if the licensee chooses a reasonably foreseeable scenario which is not clearly bounding, but then they also should consider those less likely but plausible scenarios and those would be used to inform the decision.

Next slide. The NRC uses a risk-informed approach to focus on important issues related to

public health.

Risk is defined by the risk triplet, commonly, what could occur, how likely is it and what is the consequence or the dose to the individual if the scenarios were to occur.

So, following the risk-informed approach the NRC will evaluate the licensee's approach considering likelihood.

Also, insignificant radionuclides and exposure pathways might be removed from detailed analysis if it can be justified.

Next slide. Okay. So, let's take a closer look into the less likely but plausible, or LLBP, category.

If the licensee basis its compliance exposure scenario on a reasonably foreseeable scenario that is not clearly bounding, which is said in the previous slide, then the licensee should also identify those scenarios that are less likely but plausible.

So, these are scenarios that could lead to higher doses compared to the reasonably foreseeable scenario used to demonstrate compliance and that evaluation of the less likely but plausible scenarios ensures that if land uses or exposure scenarios other than that reasonably foreseeable scenario were to

occur in the future, that unacceptably high doses would not result.

So, some prior examples of the LLBP application are the application of the resident farmer scenario as an alternative, but LLBP scenario to the industrial worker for the Lacrosse BWR site or drilling into a very specific portion of the auxiliary building piping that was left to remain for the Zion Nuclear Power Station site.

so, note that this approach discusses likelihood in a qualitative way and we may even attempt to quantify the likelihood of interacting with the particle in order to categorize a scenario or a set of scenarios as LLBP, but probability in this sense is not multiplied by the dose to come up with an expected dose to compare to some limit.

Alright. So, fully understanding that this presentation did not answer all of Bruce's questions in the beginning, but also under the assumption that this workshop is really for just generating discussion and further exploring what the answer to those questions could be, here are some questions.

Next slide. So, who are the potentially exposed individuals, how do you determine the

likelihood of interaction with the particle, and what are the risk-significant exposure pathways for DRPs? And I should add his question on there. What is the dose threshold that we're concerned about?

That's it. Thank you.

MS. LOPAS: Thank you, Leah. I appreciate that and we are going to get to Leah's discussion questions during the discussion period.

So, right now let's take a 15-minute break. We will reconvene at 2:00 p.m. When we come back, we'll have Dr. Hamby's presentation. Dr. Hamby is from Renaissance Code Development.

That will be our final technical presentation then we will move into the discussion period where there will be plenty of time for more of your questions and comments.

So, 15-minute break. Reconvene at 2:00 p.m. I recommend you don't sign off of Teams. Just keep it running in the background. Or if you're on the phone, I would just, you know, mute yourself and leave your phone connected and we'll be back at 2:00. Thank you.

(Whereupon, the above-entitled matter went off the record at 1:45 p.m. and resumed at 2:02 p.m.)

MS. LOPAS: Okay. We're going to get

started again with our last technical presentation. After that technical presentation, we'll then open it up for the discussion period. So, I'm going to introduce Dr. David Hamby from Renaissance Code Development.

Dr. Hamby?

DR. HAMBY: Hi. Thanks.

I want to recognize a couple of people who worked on the project with me and this is Colby Mangini, Charlotte Rose and Roland Benke. I'm the principal at RCD and a retired professor emeritus at Oregon State University in health physics.

So, next slide, please. Okay. So, I want to talk about two things in particular here today and I've got about 20 slides. So, it shouldn't be too long.

A recommended ulceration dose threshold I want to get into just a little bit. A couple slides about that. That topic has come up a couple of times here.

And then I'll talk about the dose coefficients for -- primarily for stationary DRPs that might be in the body or on the body, but kind of focusing on this idea of a stationary DRP.

I will say that I might say "dose

conversion factor" throughout the talk. It's kind of the old term for dose coefficient. I mean, old being 20 years ago, but dose coefficient sometimes gets called the "dose conversion factor" as well. The same thing.

When I do talk about dose coefficients, we'll talk about skin surface, respiratory tract and particles in the intestine.

Next. So, we've heard already the -- kind of the definition of a DRP. One of the things that I wanted to -- or to point out here as kind of significant is I think I found the same picture that Greg found about table salt, but showing that table salt would fit in the definition of a DRP.

But the picture above it is actually more enticing and that is it's uranium oxide from Chernobyl.

So, it's not related to these particular sites; however, but what it does point out is the jaggedness -- or the potential jaggedness of a particle.

And it's this -- it's this jaggedness and this non-uniformity that causes that particle, if it does come in contact with the inner lining of the small intestine/large intestine or even in the upper

respiratory tract, it can become lodged in that organ.

And so, that's one big takeaway from this slide is that -- is that picture. Keep that picture in mind.

You can also see that the scale on that picture is 10 microns. So, that is a particle that's about 40 to 50 microns across.

DRPs are harmful. I have two bullets there and again the big piece for that is what's in brackets and that is "for a significant length of time."

If the particle gets stuck internally or on the skin and doesn't get removed, then it could be harmful.

And I'll talk about -- later into the talk I'll kind of get into this idea of what is, you know, what is harm or what is the level of harm.

The harm here is deterministic generally related to ulceration of local tissues and that's for stationary particles in the organs.

Next, please. To start, the threshold for ulceration that we are recommending is 25 gray, a very large number, the 25 gray ulceration threshold.

And you can see that we have based that on what other groups and what other individuals have come

up with.

You see there's a couple of references there back in the early 1990s and you also see a couple of references from 2020, 2022.

So, some old and some new, but you can also get from this graphic that -- ranges from 1 gray up to 70 gray depending on what kind of risk level you want to assume.

An important thing with those two upper ones, the 55 gray and the 70 gray, is that they are pointing out that this is -- the 55 gray, for example, is a 5 percent risk. And what this would mean is that 5 percent of the population would experience an ulcer at that dose level.

The dose level of 25 gray we can show -- in a separate paper we've shown that that's related to about 1 to 5 percent incidence at that level. And keep in mind that this is 25 gray, which would be 2500 REM -- rads. 2500 rads.

Next slide, please. And then if that 25 gray were in the back -- or was in the back of our mind, then we might think what are we calculating 25 gray to? This is 25 gray to what?

And so, we had to come up with some critical depths in tissue for the tissues of the

respiratory tract and the small intestine/large intestine.

And you see those numbers up there, 45, 140, 290 microns. So, this is the depth in those areas and organs.

These are the depths where the basal cell layer occurs. And so, if the basal cells are impacted -- and this is the reproducing cells. And so, there's going to be potential there for -- especially high doses, potential there for ulceration.

This dose averaging area of one square centimeter, Greg touched on this earlier, there's a dose averaging area that we use for skin dosimetry of 10 square centimeters. So, yay big. The size of a half dollar maybe.

And that size is used for skin dosimetry because I think there's a document that dates back several years saying that the particle might be on the skin and it might actually move around, or the particle might be on the clothing, on the outer clothing and might move around during the day, staying put, so to speak, but moving around a little bit, and that's why the averaging area is a bit larger.

What we recommend here is a -- an averaging area of 1 square centimeter, which is about

the tip of your finger -- cross-section of your finger and we recommend that number because this is kind of the -- couple of things. This is kind of the maximum size of ulcers found with radiation exposure.

It allows for some of the, you know, the fringe area of smaller ulcers, allows some of the fringe area for -- I can't think of the word -- for replenishing cells and also some migration through there.

One square centimeter also is a round number, one. And so, I mean, to call it 0.72 makes no sense at all. And so, 1 square centimeter, we think, is a very good number to focus on.

And so, what this means is that when we start calculating doses to -- ulceration doses, then what we'll do is we'll calculate to these depths for that averaging area and then compare it to some threshold.

And again, this is just a recommendation. This is nothing that's been accepted, but just a recommendation of 25 gray.

Next slide, please. So, what I'm going to show you is -- we're going to go through the dose coefficients for these exposures to the skin surface, to the upper respiratory tract and to the small and

large intestine and you see a couple of bullets for each of those.

We'll calculate shallow dose equivalent -- the "DE" just meaning dose equivalent. We will calculate the shallow dose equivalent rate.

Now, the reason we calculate a rate is because we don't know how long that particle will sit on the skin.

If we want to assume the particle sits for an hour or a day or a week, then we can still use the same dose coefficient because it's given in terms of rate.

We'll also calculate a deep dose equivalent rate. And that's abbreviated DDE. The first one, by the way, is abbreviated SDE.

Deep dose equivalent is abbreviated DDE and I've got a star there because it's not exactly deep dose equivalent. And we can get into that later, but the definition of deep dose equivalent is whole-body exposure -- or includes whole-body exposure.

This deep dose equivalent is basically saying there's a hot particle on the skin or calculating dose at a depth of a centimeter into the skin. So, it's not technically the DDE definition because it's not whole-body exposure. And then we'll

calculate an effective dose equivalent rate for a particle on the skin.

In the upper respiratory tract we are going to focus on the nasopharynx region up in the nose and the face.

The particles that we're looking at here are between about 10 microns and 1,000 microns and those particles are too large to go any deeper.

And like Greg pointed out, we're not talking about AMAD or distribution of particle sizes, but we're talking about one particle size that gets stuck up in the nose. Probably be sneezed out/swallowed potentially.

We'll calculate the EDE rate as well. We'll calculate that rate for a stationary particle because -- what I'll talk about in a little bit, maybe, is the -- if the particle is moving, then the doses are going to be minimal and we can use other dose factors or dose coefficients for those calculations, but it's when it becomes stationary is the potential problem for DRP.

And then in both the small and large intestine, two different calculations here I've listed only once, though, but the ulceration dose rate like with the respiratory tract, the EDE for something

stationary, and then we'll also calculate an ingestion CEDE.

The "C" means committed and it's basically an internal dose that the person who has this particle in them is committed to. And so, calculate a committed effective dose equivalent for ingestion.

It's not appropriate for upper respiratory tract to calculate CEDE because that particle will likely be inhaled and then lost to the environment. It won't go through the system.

And so, for a committed dose, it basically has to go through the system. For the small or large intestine we are assuming that the particle goes through the entire gastrointestinal tract.

Next, please. So, this is a list of nuclides that we've considered for five different materials from Stellite, Inconel, concrete, fuel fragment, welding rods.

Just a couple of notes here. Concrete, there's a document from PNNL that we went by for the makeup of concrete and I think there's something like 26 different makeups of concrete. And so, what we did because of where we're sitting, we chose, quote/unquote, regulatory concrete.

You can see up there the effective atomic

number and the density of that material -- for each of the materials.

What I will point out, too, is the fuel fragments. All the DRP materials you see here are assumed to be intact, assumed to go through the body intact except for fuel fragment.

The fuel fragment we've done calculations kind of in both ways that that could -- the fuel fragment could dissociate -- could dissociate at different levels.

And this is really hard to -- it's hard to -- it's actually hard to determine what that would be. So, what we've done is given bounding cases because a fuel fragment might be broken into two or it might be broken into six million pieces.

And that really depends -- and what that does is that depicts or dictates how that particle moves through the body and how it moves into other organs. So, that's significant and we'll get to that at the end or close to the end.

Next slide, please. So, one slide here about VARSKIN. VARSKIN originally developed in 1987 for hot particles and it's been around a long time.

We've had the contract for VARSKIN since 2008. So, we know VARSKIN very well. We've done a

lot of upgrades to VARSKIN.

Originally intended only for beta emitters, but we've worked -- enhanced it to calculate now alpha, beta, gamma.

And beta and gamma doesn't just mean -- I'm a very literal person. And so, beta/gamma doesn't just mean beta/gamma. It means electrons and photons. So, everything.

Doses from skin or clothing contamination is what it's intended for generally. We have -- when we use VARSKIN, we're going to use it for skin dosimetry, we're going to use it for upper respiratory tract dosimetry and for intestinal dosimetry.

It works very well in those cases because there's not a lot of difference between a particle sitting on the skin surface and calculating dose at some depth to a particle sitting inside on the inner wall of the intestine, for example, and calculating dose at some similar depth, hundreds of microns, some similar depth as you would for skin. That's what the last bullet says, essentially.

Next slide, please. So, first of all -- and you can go back one. So, we're going to talk about skin surface first.

So, there's a particle on the skin

surface, spherical diameters from 10 to 100 microns -- 10 to 1,000. 1,000 microns is a millimeter, by the way.

Bulk density and effective Z, effective atomic number, are necessary in the VARSKIN code for self-shielding. So, the size of the particle matters. If the -- larger particles obviously will have more self-shielding than the smaller ones.

And we're going to calculate shallow dose equivalent, calculate that to tissue, to skin tissue at a depth of 70 microns over 10 square centimeters.

So, there's an imaginary infinitely thin disc of 10 square centimeters at a depth of 70 microns where you can get the particles impacting that disc.

And then we'll also use this skin dose module in VARSKIN for deep dose equivalent again with a star, calculating dose at the depth of 1 centimeter and again with a 10 square centimeter averaging, and then we're going to calculate effective dose equivalent.

So, this is a particle -- essentially a particle is sitting on the skin's surface and what we've chosen is the torso and the calculating dose to each organ and multiplying those organs by their tissue weighting factors to come up with an effective

dose equivalent.

We put the particle on the torso. There were actually many, many, many runs done in MCNP with the particles in various locations and we found kind of what makes sense is that the particle on the torso means the most to effective dose equivalent because it's right by all the critical organs.

Next, please. We also used a code called PiMAL. It is a phantom which looks like that and you can couple it with MCNP. And you can see that the phantom there has organs and I think there's 24 different organs in that phantom.

So, you can place the source outside the phantom or inside any particular organ and you can calculate dose to any of the organs you want to calculate to.

So, this is where we -- for a particle on the skin, we put the particle in different places around the body and then calculate dose to various organs.

And then for the tissue weighting factors, this is actually defined in 10 CFR 20 that the tissue weighting factors, gonads, breast, red bone marrow, lungs, thyroid, bone surface, and then the remainder is the next six -- I think it's six, five, six organs

get included in that summation.

Next, please. So, this is a table of many. I don't want you to necessarily look at numbers. That's not the point of this, but the point is it's more to show kind of this matrix of nuclide and particular hot particles for particular DRPs.

And the only reason that the DRP form is of significance is because the density will change and the effective Z will change, which you can see there -- maybe you can make it out.

If you look at Stellite 6, for example, and you move across, you'll see a Z of 33 and a row of 8.4. And so, those numbers are significant in VARSKIN.

And you also notice that we've calculated the SDE dose coefficient in terms of sieverts per becquerel hour from a size of 10 microns up to 1,000 microns.

So, if you were so inclined to look at these numbers and start comparing numbers in your mind and so forth, you might look across there and see -- if you see numbers for some nuclide and they vary greatly between 10 and 1,000, I think you can pick out a couple that might vary by two orders of magnitude over that range, that basically means you have a beta

emitter that's being absorbed by the particle size.

If you see numbers that don't really change as you look across, that means it's a gamma or photon emitter. That really is not influenced by its size.

Next, please. So, for ingested or inhaled DRPs, we're also going to use the VARSKIN model and we're looking at particles that stick to the inner surface of the respiratory tract or the GI tract.

In the calculation, obviously the -- if you think about the small intestine, for example, obviously the small intestine is curved.

It's curved, the inner lining, and you have a particle that's calculating -- or a particle that's emanating radiation being collected by the organ.

One of the limitations of VARSKIN is that the tissue is flat. So, we basically took something that is a cylinder and we've opened it up and the source sits here.

If we're concerned or if we're interested in calculating the entire dose to the curvature of the organ, then that's going to make a difference and that's going to make a difference by about a factor of 2. We've looked at this. It makes a difference of

about a factor of 2 that when the -- if you have a source here and you curve that over about a factor of 2 increase in dose.

What we're doing, though, is we're calculating dose to one square centimeter at a very shallow depth.

And so, the assumption that we're making is that that curvature does not matter in calculating dose to something -- to something that is that size.

So, then dose coefficients calculated at those -- at those depths again and we're calling it local dose equivalent, like Greg suggested, dose coefficients are there then. Again they'll be in units of sieverts per becquerel per hour -- or sieverts per becquerel hour. And that is so that you can plug in what time -- what exposure time is of interest.

Next, please. Then we'll calculate the effective dose equivalent -- dose coefficients for internal DRPs.

Again, we're going to couple this with PiMAL and MCNP. The location is in the upper respiratory tract, large and small intestine, and we'll assume that the DRPs remain whole and stationary so that there is no dissociation.

Even the fuel fragments in this case, they're whole and they're stationary. That's going to maximize dose. It's going to maximize this ulceration dose.

There's been a little bit of talk today about doses to children and everything that I've talked about to now -- I guess the previous slide when I talk about PiMAL, everything I've talked about to now is age independent, but calculating an ulceration dose, that dose is calculated the same whether it's adult or child.

The one thing that might be a -- could be a saving grace for a child, so to speak, is that the children's -- a child's cell turnover is rapid. And so, an ulceration might be less likely in a child given the same dose as an adult.

So, it's kind of the opposite of the way we typically think of children's exposures, but just something to keep in the back of your mind.

Next slide, please. Then we calculate the committed effective dose equivalent for the internal DRP. And, again, this is a DRP that's in the upper respiratory tract or is in the intestine -- somewhere in the intestinal tract.

We use IMBA. IMBA is another code that's

in the RAMP package. IMBA is a code developed out of the UK. Basically calculates internal dosimetry.

And the nice thing about IMBA is it uses the -- it uses the same models that are contemporary to 10 CFR 20. That's really the main reason for using IMBA in this case.

Again, the DRP remains whole, it does not go to the bloodstream, and it's moving through the body.

And then I have a note here for the fuel fragment exception. There will be some -- or there could be some activity sloughing off of the source and then entering the bloodstream.

It's not -- like I said before, it's not known how much -- like, what fraction that would be. And so, we've given several different calculations through IMBA for different amounts of activity making it into the bloodstream from a fuel fragment.

The idea here is that the particle is moving for the committed effective dose equivalent. And then if the particle gets stuck, we calculate the ulceration dose.

So, for this dose, for the committed effective dose equivalent, the particle is assumed to be moving and typically the particle is expected to be

moving with the contents -- the contents of the intestine.

And so, if it's moving with the contents of the intestine, then what we would recommend is that we use FGR 11, the Federal Guidance Report 11, dose coefficients for a particle moving with material.

Next slide, please. Inhalation, we don't calculate an inhalation CEDE. And the reason being, it says here, I've said a little bit of it already, but the particle is inhaled and it might sit there for a couple hours and either be swallowed -- and if it's swallowed, then it becomes an ingestion calculation.

But if it sits here and it gets sneezed out, then it was sitting for a while. And so, the CEDE, this idea of committed effective dose equivalent doesn't really apply.

We calculate effective dose equivalent for a particle sitting in that region, which we do using MCNP, we can calculate effective dose equivalent, but that would be associated with certain exposure time.

CEDE has no exposure time as a 50-year integration. That's why it doesn't make sense to do this for inhalation.

Next slide, please. For ingestion, again, using IMBA, the ICRP 26/30 weighting factors, the

biokinetic model in ICRP 30 was not intended for DRP ingestion events.

But if you look at the mathematics like Greg talked about, then the models show there are, you know, it's a compartmental model and these compartmental models assume that some amount goes in the first compartment, and then some fraction gets moved to the second compartment, and then some fraction of that moves to the third compartment.

So, if you only have one particle, that fractional movement isn't happening, but mathematically you can show that the dose for -- committed effective dose equivalent is going to be very close to the same, if not the same, value.

It's only a matter of where that particle is sitting in the small intestine, for example, as to whether or not it's going to be the same as the FGR 11 dose coefficient, for example, just based on physical location where that particle is in irradiating other organs because the ICRP 30 model -- 26/30 model would say that the activity is uniformly distributed through the organ. And, in this case, it would be one piece sitting somewhere in the organ and it's not stuck.

Next, please. And sorry for the small print. This is a similar table for CEDE ingestion and

what you notice here is that there is a second column.

So, the first column -- if you look at the top, the first column says, f1 equals zero. So, f1 is the fractional movement from the small intestine to the bloodstream.

If f1 is zero, that means nothing goes to the bloodstream. That means the particle moves from stomach, small intestine, large intestine, out. It does nothing to other organs of the body except maybe external exposure or photon exposure from where it's sitting, but it doesn't -- it doesn't move into other organs if f1 equals zero.

And so, you see that f1 is zero for everything that we calculated, including fuel fragment.

And if you're looking in that column, you would say, okay, the fuel fragment has not dissociated. It's still one piece and that would be the dose factor -- dose coefficient for all one piece.

FGR 11 is calculated assuming that that particle, whatever that particle is, has completely dissociated.

And also what FGR 11 does is it says -- for example, the first one is stronium-90. And so, what we're doing here in the f1 zero column, we're

assuming that material moves with the contents of the organ.

What FGR 11 is doing, once that -- once some of that material makes it to the bloodstream, then the material is moving as the element.

So, for stronium-90 there is the -- there are tables and tables and tables of how materials or how stronium-90 -- or how strontium, sorry, how strontium moves in the body once it goes to the bloodstream and all the organs, how strontium moves, how cesium moves, how europium moves, and that's what is used for FGR 11.

So, there's a little bit of mixing of apples and oranges here; however, what we've done is we've maximized that difference. So, f1 is zero and then FGR 11 is going to be the bounding case.

Okay. We've also -- I don't show it here, but in the report we have a couple more columns where we have picked some values of f1 that are somewhere between zero and everything, like, I think at 1 percent and at 10 percent, something to that effect. So, you can get a better view, but you're still going to be bounded by these two numbers.

Next slide, please. So, my summary slides are these last two and I have a Stellite (Cobalt-60)

example, and then the next slide, I think, is a fuel fragment (europium-154) example.

What I wanted to show here is the various dose coefficients that we've calculated. You see we have skin exposures, we have upper respiratory tract exposures, small intestine, large intestine, and then one for general GI tract because that is an MCNP model, and then ingestion with the CEDE.

And the third column is the dose coefficient and you see, for the most part, it's sieverts per becquerel hour except for the last one. And that's just sieverts per becquerel because it is a committed dose.

And then we have -- the next column is reasonable maximum exposure time. What is a reasonable maximum amount of time, for example, that -- looking at the first row, what's a reasonable maximum amount of time that a particle might sit on the skin's surface? One day. Maybe between showers or some -- somebody is contaminated right after a shower and then they shower the next day.

So, this is a -- and we want a reasonable number, a maximum number, try to estimate to see what the maximum dose could be.

And if you take the -- for this cobalt-60

example, you see in the note down at the bottom it says the -- we've assumed 100 microns with a cobalt-60 activity of 50 kilobecquerels.

And the 50 kilobecquerels comes from a very rough calculation of a particle that size with a specific activity -- a nominal specific activity.

And so if we assume that 50 kilobecquerels and it's one hour -- or stuck on the skin for one day, with that dose coefficient we can calculate -- that next column says, Estimated Maximum Dose in millisieverts. That's about 44 millisieverts if that particular particle were stuck on the skin for a day.

And then the next two columns are time required to reach half a sievert in days and then time required to reach 25 gray in days.

And so, you see that if the particle were stuck on the skin's surface for 560 days, you'd get right at 25 gray. That's what that's meant to show.

One of the things that kind of caught my attention with looking at these numbers, particularly those last two columns, you know, how long does it take to reach a dose limit, is the small number, where is the smallest number.

And you see consistently, and I think we'll see it in the next slide as well, but we see

consistently the smallest number is the upper respiratory tract and it's the local dose equivalent to the upper respiratory tract.

And you can see that my assumption is 48 hours, two days, spending in the upper respiratory tract.

And we can argue about times and all this until we turn blue, but the point being is that if we try to estimate what that time might be, we really have no idea. For every person it might be different.

But what this points out, though, is that the upper respiratory tract exposure for a hot particle might be driving things.

Let's see. I don't know if there's anything else to point out necessarily. Next slide, please.

So, this is the fuel fragment, Europium-154. Again, if we kind of focus on the last two columns -- or the last three columns, we'll see what's an estimated maximum dose in millisieverts.

Note the note at the bottom that this is for 100 micron particle of Europium-154 with activity of 8 kilobecquerels.

And the reason that's not 25 like the previous one, whatever that number was, the reason

it's not the same number is because the specific activity of Europium-154 and a fuel fragment is different. So, this is a reasonable than 8 kilobecquerels for this size particle.

And, again, if you look, say, the second-to-last, or even the last column, you'll see that the respiratory -- the upper respiratory tract tends to show that that's the placement of a source of this size that would reach some kind of threshold quickest.

And I don't see anything else to point out there either and that's the last slide. So, we'll stop there.

MS. LOPAS: Okay. Thank you, Dr. Hamby.

So, at this point, we are going to go into the discussion portion of the meeting. So, we're going to kind of work it the same way we did the kind of Q&A portion earlier where Brett will be working with folks that are online.

So, go ahead and raise your hand if you're on the Teams or press *5 if you're on the phone, but we are going to start here in the room with the representatives at the table.

If you all would -- if you have any questions or comments at this time -- or we could wait. You could tell us to go to the Teams, too.

So, I just want to remind everybody before you start talking, introduce yourself just so everybody can remember who's talking and for the court reporter to get an accurate transcript. And the folks in the room, you must be speaking into a turned-on microphone and try to get close to your microphone.

Okay. With that, I'll be quiet. So, I'll hand it over to Bruce and company to see if anybody wants to start off over there.

MS. ROBERTS: Sarah Roberts, EnergySolutions.

My questions, and then a comment for Nick Altic from ORAU/ORISE -- is he still with us, I assume?

MS. LOPAS: I think so. Nick, you are on the line, correct?

MR. ALTIC: Yes, I'm here.

MS. LOPAS: Okay. Great. Alright. This question is for you.

MS. ROBERTS: So, Nick, first a question.

The assumptions for your integrated detector response method that you described, were those assumptions that you came up with or ORISE came up with or where did those assumptions come from?

MR. ALTIC: I mean, those -- so, those

originated from us in-house and it's basically just that the audible responses from the rate meter is happening in real time and that that integrated response occurs -- that is, represents that sort of peak in audio response.

I don't know if that answers the question, but --

MS. ROBERTS: Yes. Okay. I just wondered if those assumptions came from a particular document or if those were assumptions that you came up with just for your study in that then. So, I think I understand your answer.

And then I wanted to -- just a comment. I appreciated the comment that you made about the 0.25 meters per second really not being a realistic scan speed for large sites, you know, especially for scanning a hundred acres or more, and that you did point out that it would be appropriate for an investigation method, so for small areas to be investigated would make sense.

So, to me, that points to the need for new and improved technology for scanning that I believe, as an industry, we're very focused on. And so, I just wanted to emphasize that point that you made and I appreciated that. And that's all for me for now.

MR. DAROIS: Hi. This is Eric Darois from RSCS.

I've got some questions and comments on both -- on the scanning as well as the dosimetry side. So, I don't know if I put them all together, take them one at a time, but I can do either.

I'll do the scanning first. I would encourage you to take a look at some advance technologies for scanning.

Obviously, what ORISE did is applicable to the scanning technology that goes back 20-plus years ago and since then we have got detection systems that use the same detectors that log with GPS coordinates.

They can log spectrums, they can log count rates, but it can give you millions of data points that can take the human element out of trying to interpret a difference in audible signal.

And I think that's very powerful, so I wouldn't stop with the old technology. I would also consider some of the new stuff. So, not really a question, but just more of a comment.

Couple of the things on what you did, Nick, overall I thought it was good. You tested kind of in a laboratory environment, but we know that when we deploy these things to the field, we see background

radiation levels being rather heterogeneous whether it's from, you know, distribution differences in natural-occurring radioactive material or other extraneous sources.

And that's going to give some challenges to being able to detect the audible change as backgrounds change because you're looking at a very small signal. So, I'll just leave that to you to think about.

The other thing I'm just struggling with and I don't quite know the answer, but it would seem to me that you're listening to the audible signal, which intrinsically is averaging over some intervals of time.

I don't know what those intervals are, but, you know, it's the "last one in, first one out" kind of a thing where it's adding an increment -- I don't know if it's 0.01 seconds or whatever the number is -- in displaying this audible signal again and you seem to have optimized the peak to represent the highest signal.

I don't know if it's right, I don't know if it's wrong, but I just wonder whether it's treated correctly in that context.

So, the other thing -- I'd like to shift

gears a little bit. Leah gave a presentation and mentioned that the, you know, for particles, the probability of encountering a particle shouldn't be multiplied by a dose to get this compliance comparison, but I'll just point out that in the Shelwell case that's what NRC did. They multiplied probability by dose to get expectation dose. That was what the term was called.

So, it was done in the past and apparently it shouldn't be done in the future, but I'll just leave that as a comment as well.

On to the dosimetry side. I think there's some literature that would be worthwhile reviewing for the solubility issue for irradiated fuel.

I point to ICRP 137. It has a discussion on the solubility particularly of cesium-137 in irradiated fuel.

And they show that the cesium-137 solubility drops by a factor of 10 compared to Federal Guidance Report 11.

So, I did similar calculations and assumed that factor of 10 applied across the other radionuclides.

There's also a piece of work that was published in Environmental Health Perspectives in '95,

a group from Finland that studied irradiated fuel from Chernobyl in humans and they conclude that DRPs -- or irradiated fuel is inert to the human body.

So, I leave you with that. I've searched long and hard for this kind of information and that's the only two things I found, but I just want to share that with you.

DR. HAMBY: We found those as well.

MR. DAROIS: Okay.

DR. HAMBY: And there's not a lot else out there.

MR. DAROIS: Yeah. Okay.

DR. HAMBY: One of the things that it says about fuel fragments was that they would dissociate or come apart or something in the environment.

And so, in the environment, we figure, is less acidic than the stomach and that's kind of one of the things that, you know, okay, it can come apart.

MR. DAROIS: So, I have some --

DR. HAMBY: We don't know how much.

MR. DAROIS: Sorry. I have some anecdotal information from my career having worked at places that have had severe fuel failures.

And it's only anecdotal, but what I have seen what appears to be the case is that these

particles will break apart -- not chemical dissolution, they'll break apart from alpha recoil.

So, they get smaller, but their activity goes down just, you know, those specific activities are the same. So, it's not a chemical, it's rather a physical phenomenon.

DR. HAMBY: Yeah. And that's actually a good point in terms of, you know, when -- if a fuel fragment is ingested and breaks down a little bit, just comes, you know, into five pieces, those five pieces are still going to behave in the body most likely like a fuel fragment --

MR. DAROIS: Yeah.

DR. HAMBY: -- and not like the individual components.

MR. DAROIS: Yeah. Yeah. Agreed.

Okay. Almost done. You used as one of your examples Stellite as the Cobalt-60 piece, and I'll just offer up that I believe a lot of plants have gone through great efforts of removing Stellite from their source terms.

And in a decommissioning space, I think that one of the sources that probably would trump Stellite would be internal reactor components that get cut up during decommissioning. So, the opportunity to

generate particles.

So, I've done a similar analysis where we've looked at deactivation of in-core components, use that as like the highest activated metal that you can really get in the plant. So, just something to consider.

And lastly, the exposure times you had in the last two tables for the lung and even the small intestine/large intestines, it seems to me the implied -- the implication is that the particle stays stationary for that one or two days or five days and that, in reality, it's probably moving, irradiating different tissues -- different subtissues.

DR. HAMBY: Yeah. Let me say some more about that.

Those times of reasonable maximum are basically -- especially through the intestine, is -- we looked at the literature for a lot of different travel times and rate constants and so forth and came up with a range -- as I look at a range, it is 2 to 8 -- let's call it 10.

Now, that's assuming that you have somewhat reasonable movement through the gut and that the particle is staying with the contents of the gut.

MR. DAROIS: Um-hm.

DR. HAMBY: What we don't talk about in this presentation -- in the paper, what we don't talk about in this presentation is that there is evidence of particles sticking in the intestine for three weeks. And so, if the particle sticks in one spot for three weeks, then that's a problem.

And the likelihood of that happening, you know, maybe geometrically you could calculate some likelihood of it, but basically that particle, that jagged particle -- well, the particle would have to be kind of jagged -- it gets on the edge of the contents, comes into contact with the lining of the wall and somehow, as it's rolling through, it sticks and then has to stay there. And so, the likelihood of that is very small, but it has been documented.

And the way this was determined for this one particular case that I'm thinking about, was a GM detector was put on the chest or stomach, wherever, yep, still there. Next day, still there, still there.

MR. DAROIS: I think I'm familiar with that case.

DR. HAMBY: Yeah. And then all of a sudden it's gone.

MR. DAROIS: Yeah.

DR. HAMBY: And so -- and I believe that

was like three weeks.

MR. DAROIS: Right.

DR. HAMBY: And so, it's --

MR. DAROIS: And it's the same case that was unique in that the individual had been sick for a few weeks prior to the event and basically had an empty GI tract. So, there was no -- there was no motive force.

DR. HAMBY: Right.

MR. DAROIS: so, it was an unusual circumstance and I certainly would hope we wouldn't base regulatory guidance on that because it's pretty extreme.

DR. HAMBY: Yeah. And I'm not the regulatory guy, but --

MR. DAROIS: I understand.

DR. HAMBY: -- that's why I did it that way.

MR. DAROIS: Yeah.

DR. HAMBY: It's as a reasonable maximum --

MR. DAROIS: Okay. Great. That's all I have for now.

MS. LOPAS: Bruce, did you have anything to add?

MR. MONTGOMERY: I just wanted to get

those initial reactions to the presentations done first.

I think maybe, you know, if there's other questions online from my team, they should speak up right now.

If not, then I think maybe we can move -- oh, sorry.

MS. ROBERTS: Yes. Sarah Roberts. I have one more follow-on question based on something that Eric mentioned and, Leah, this was in your presentation.

Eric mentioned, you know, for the less likely but plausible scenario it was mentioned that probability is not multiplied by dose to compare to the limit.

And I apologize if I missed this, but when you say "the limit," is there a particular number or criteria that you were referring to there or is that something that's not yet been defined?

MS. PARKS: So, as Greg mentioned, and others also mentioned before, we have a 25 millirem TEDE limit defined in the regulations. We do not have other limits defined besides that.

We have an approach that considers likelihood in sort of a qualitative fashion where if

scenarios are less likely but plausible and not the reasonably foreseeable scenario, they are permitted to give more dose than the 25 millirem because they're not the compliance scenario.

So, the precise limit that is compared to that less likely but plausible scenario is not defined in the regulation and I think it's reviewed on a case-by-case basis.

MS. ROBERTS: Thank you. I appreciate that.

MS. PARKS: I'd also just like to take a moment to clarify what I was trying to describe in terms of not calculating an expected dose is that under the less likely but plausible scenario or approach in NUREG-1757 Volume 2, it is not discussed to multiply that probability by the dose.

It's just considered a less likely but probable scenario and then you discuss what the dose would be, if that scenario were to occur, so that you can ensure that an unreasonable dose doesn't happen under that scenario.

And I, you know, I'm aware of Shelwell and that did calculate an expected dose that was different and separate from less likely but plausible.

MS. ROBERTS: Thank you.

MR. MCKENNEY: Chris McKenney, NRC.

The one other thing is is that having the data presented to the NRC in a disaggregated form and probability and consequences separately, we can evaluate both separately a little easily and discuss that.

In the end, it may actually be -- the decision may be the result of the actual quotient between the two, but it also can be discussed and evaluated in a separate form rather than if it's just provided in an aggregated form as just an effective value.

Then, there can be -- start to be leading of some other ways to look at -- in a risk-informed manner that we'd have to then get more information about and stuff like that whereas as if it is provided in this aggregated way, we can use different evaluations and stuff to look at it from a risk-informed manner and whether the uncertainty around the probability is is that what's driving everything or is it, you know, which -- do we have enough information from either one or do we need to pursue what type of uncertainty do we need to evaluate as part of the decision.

MS. LOPAS: Okay. So, now I am going to

move to anybody on the Teams chat. So, we'll go with -- Brett, I'm going to hand things over to you a little bit to try to facilitate that and see if there's any comments that you want to read aloud or questions that need to be read aloud and if anybody wants to ask a question or comment. Thanks.

MR. KLUKAN: So, again, to ask a question or a comment if you're participating via Teams, please use the "raised hand" function in the Teams app, which should be up in the right-hand corner of your screen. Or if you're joining via Teams browser, same thing.

If you're participating via phone, press *5. Again, that is *5 to raise your hand. And then once I call on you, you'll need to press *6 to unmute yourself.

So, while we're waiting for individuals to cue up, I have a question here from Jack. My experience with ORISE was that they use a smaller Nal detector. Has ORISE moved to a two-by-two-inch Nal detector for IVC or only when DRP is suspected?

I guess that might be a question for Nick.

MR. ALTIC: Sure.

I mean, obviously the specific site kind of dictates and project DQOs kind of dictate what instrument we use, but I would say that, in general,

the two-by-two sodium iodide is our go-to detector of choice for gamma walkover surveys.

MR. KLUKAN: Alright. Thank you for that, Nick.

Again, to raise your hand -- oh, we do have someone. Steven, I have unmuted your microphone. So, whenever you're ready, please feel free to unmute yourself and begin your question or comment.

And this, again, is Steven Rademacher.

Steven, you will need to hit the microphone icon in your Teams app or Teams browser to unmute yourself as you're still showing up as muted on our end.

Looks like we may have lost Steven. I will put the -- in the chat again the bridge line information in case anyone needs it again.

MS. LOPAS: I can show it to you, Brett. I'll pull up that slide.

MR. KLUKAN: Okay. Great. Thank you.

MS. LOPAS: Give me a minute to do that.

MR. KLUKAN: Sure. We did have a couple comments related to Rocky Flats. However, that's kind of outside the scope -- or that is outside the scope of this meeting so we don't -- this isn't really the context in which to discuss those.

However, thank you for the individuals who raised those comments and are participating in the meeting today.

And, again, the bridge line is up on the screen right now for those of you having trouble unmuting yourselves.

And, again, you can either raise your hand, put your question in the chat. Or if you're participating via phone, press *5. Again, that is *5.

MS. LOPAS: Alright. And, Brett, you know what I'm going to do? I'm going to pull up our discussion questions and see if that eggs anybody on.

So, let me go ahead and -- "egg" probably isn't the right term to use, but, you know, spur some discussion. So, give me a second to do that here.

Alright. Here they are. Let me go to the first one here. And, Brett, I think -- were you going to read these aloud?

MR. KLUKAN: Yes. So, for those of you participating via phone, I'm going to read through the first set of discussion questions regarding the ORISE/scan, the minimum detectable area, or MDA, questions.

Again, these are found on the NRC's public website under the page for this meeting. So, you can

pull these up yourself. But, again, for your convenience, I'm going to read these out loud and I will try to go slowly.

Can a surveyor expect to achieve even lower scan MDAs if using collimators or larger detectors?

How does a licensee address scanning if a DRP contains mostly hard-to-detect radionuclides, otherwise known as HTDs?

Is a scan for DRPs sufficient to also satisfy MARSSIM scanning requirements (e.g., sufficient to identify elevations above the DCGL)? Note: This preferred approach is to address DRPs prior to the final status survey, or the FSS.

What may be considered an "adequate" scan MDA and investigation levels for DRPs (i.e., what is the expectation for sites with DRPs)?

Should a surveyor use an alarm set point to indicate when the scan MDA is exceeded and/or requires investigation?

Would the MARSSIM classification system apply with respect to scanning requirements for DRPs (e.g., 100 percent scan survey for Class 1 areas)?

And finally, are there other good practices beyond what was discussed today when

scanning for DRPs?

So, if you have comments on any of those questions, please feel free to chime in, again, by raising your hand, putting it in chat, or by hitting *5 if you are participating via phone.

MS. LOPAS: It looks like Steven is back via phone.

MR. KLUKAN: So, Steven, what you need to do -- well, let me -- I will unmute you just using your phone number. So, just give me one second.

MS. LOPAS: I'm not seeing his phone number.

Are you, Brett?

MR. KLUKAN: I am not, Sarah.

Steven, could you hit *5 on your phone?

Alright. While we're waiting for Steven, why don't we discuss a question posed by Jack.

Would an elevated scan MDC for a DRP require additional sampling? And if so, how would that be done?

Again, the question from Jack is just for those participating on the phone: Would an elevated scan MDC for a DRP require additional sampling and how would that be done?

MR. CHAPMAN: This is Greg Chapman.

So, the first thing to be considered there is what the potential dose from the DRP would be. So, what is the activity level of concern.

And if your scan MDA exceeds that, at that point in time there are different things that have been done in the past.

The best example -- or one other example, I should say, that I can give you is the Hematite site where they had fuel fragments in some of the reuse soil.

And for that limited amount of material it was still an extensive undertaking, but they used a soil sorter and segregator-type equivalent to run it through and try to find anything of elevation that would then segregate out as waste.

And so, that's one possible solution to that.

MS. LOPAS: Okay. Thank you, Greg.

Brett, I'm wondering if we try to make Steven a presenter, maybe he could -- maybe that would help with his microphone situation, too.

MR. KLUKAN: Alright. Steven, I have made you a presenter. So, you should be able to just -- you were already unmuted. Can -- yeah, we can hear you. Go for it.

MR. RADEMACHER: Excellent. Thank you so much.

I have done some clearance before, like, a number of other individuals have talked about Rocky Flats, and our experience is specifically more related to plutonium.

And I recognize that's not the primary focus of this workshop, but I do believe that at some point the NRC should look at more of the stochastic type of criterion for discrete particles. Specifically, those that are not designed -- that do not primarily give external dose, but more of a primary internal dose concern where you do have some solubilization, for example.

In the case of weapons-grade plutonium, they have used probabilistic distributions for intakes to help bring that more into a probabilistic type of paradigm.

And I think that is one of the weaknesses that the NRC has at this time because you're primarily holding to a, you know, dose limits without any probability distributions which can be an effective way to solve those problems.

That's all I have. Thank you.

MR. KLUKAN: Thank you, Steven. And thank

you for bearing with us as we try to figure out those technical difficulties. So, thank you.

MS. LOPAS: Okay. Boby has his hand raised, I see.

MR. KLUKAN: So, Boby, I've unmuted you. So, feel free to unmute yourself whenever you are ready.

MR. ABU-EID: Yes. Can you hear me?

MR. KLUKAN: Yes.

MR. ABU-EID: I think now today we are dealing with very important questions. We are talking about scan and their uncertainties in detection limit or scan. And then we actual a long time ago during my 31 years of experience, we have what's called in-situ gamma spectroscopy, for example.

Most of this is based on this discrete sampling. This means we no longer sample in the lab, and you look at the uncertainties that are involved in this.

Now, for this -- in this case when you do scanning, you are trying to integrate actually over certain volume.

In-situ gamma spectroscopy to create over somehow medium volume which is five cubic meters. And we accepted that, but we said, okay, you need to do

benchmarking where you do discrete sampling and try to see the differences.

If you find for the size of the average, there is some consistency and then that complies with the 25 millirem criteria. We accept that and we did accept in-situ gamma spectroscopy.

Therefore, there are some techniques that really are accurate for scanning and benchmark by discrete sampling, as well. And I think there is new technology that can be applied where you scan using robotic technology and highly sensitive detectors.

I think this could be one way of smart way of doing things, but we need to benchmark versus discrete sampling and confirm that the average size that meets the criteria, that is one thing.

Other than that -- one area we did not talk about when we talk about discrete particles, of course it varies into the surface or subsurface and there is difference when it is in the surface versus subsurface.

The reason is discrete particles when we talk about inhalation dose and internal dose, and that's important in this case, we need to talk about the activity of the scenario. Is somebody going to cultivate the area? Going to leave the area?

And then if this is the case, we need to talk about the resuspension factor. How much actually can go into the atmosphere and to be taken or to be inhaled by the individual?

It does not mean that every discrete particle that is there is going to be exposed that the individual would be exposed to.

We talked about probability, but it is very difficult to answer to probability for discrete particles that could reach the individual.

So, one aspect for you to think about is resuspension factor or mass loading factor. We did that in our screening analysis and we found that in our Reg Guide we found that was really conservative. We did address this again on mass loading and the resuspension factor.

So, that's another, too, we can think about in order to address the issue. Thank you.

MR. KLUKAN: Thank you, Boby.

Okay. Next, we're going to go to Jan Boudart. And I apologize if I'm not saying your name correctly.

I have allowed your microphone. So, whenever you are ready, please feel free to unmute yourself and begin your questions and/or comments.

MS. BOUDART: Thank you for the chance to make a couple of comments.

My first comment is about the method of scanning back and forth. I don't know how much of this to go into, but even primitive people when they found that they were not successful in hunting for certain animals, they would refer to the gods by putting a skull on a fire.

And when it cracked, that skull would tell them which direction to go and, you know, it would be because the tribe would be caught up in doing one thing and going to one place or going to a series of places and they needed to change their method.

And I think, Nick -- It's Nick Attic, right -- no, Nick Altic. He was the one who did this presentation and I would just simply suggest that the back-and-forth is fine.

Then there should be an angle going back and forth, and another angle, and then going up and down.

You need to change the direction of the scanning because you get stuck in doing things a certain way and you need to jar your brain into thinking of a different method.

The next thing I wanted to talk about was

the gamma walkover. That's very interesting that you're detecting gamma and I don't see how the types of radiation that really affect the biology of human -- of animal -- the biology of everything can be accurately evaluated with gamma radiation because alpha and beta are much more effective in the human body than gamma is.

And I think that this presentation today is really helping me get through the paper that was submitted with the invitation to this meeting and I -- most of the graphs and -- were familiar to me.

I basically went through the paper and looked at the pictures. So, anyway, this presentation is really going to help me get through the paper, the reading part.

So, I -- and then other things that I've put in the chat and I wanted to just establish respect for -- I've already established respect for the way primitive tribes changed their methods so that they can improve their hunting luck and I think this applies to us.

And I also feel that what happens with scientific investigations is that anecdotes from the actual people who have had experience are underrated like the old original Chernobyl book was dissed

because it was so anecdotal, and yet there was anecdote after anecdote after anecdote. And all of these stories that people tell when you look at them as a whole, these comprise data.

And I feel quite strongly about that and I think ignoring our Native Americans and their stories about how they've been affected and ignoring the people of Chernobyl -- for example, the question how many people died at Chernobyl? That is a very unhelpful question because the question is, how many people died because of Chernobyl?

And there are so many anecdotes about this that people think, well, you know, there's some number, 33, 54 people died at Chernobyl. But the number of people who died because of Chernobyl, you have to read their stories to understand what happened.

So, those are my comments and I appreciate your patience with listening to this and thank you very much.

MR. KLUKAN: Well, thank you very much, Jan, for offering us your comments and for participating in the meeting today.

Others with respect to the discussion questions on this slide, again, please feel free to

raise your hand or press *5 if you are participating via phone.

Jack raised a question: When should a site consider a visual sample plan presence or absence sampling goals as opposed to a typical MARSSIM sampling goals for DRPs?

And Greg has responded to that: A presence -- Greg Chapman has responded: Presence and absence could be used to determine a probability estimate for a number of DRPs on a site or survey unit; however, this should be considered on a case-by-case basis because of variability in the extent of DRP distribution and to ensure proper methods are utilized to evaluate the areas being collected. It is recommended you consult with your regulator to ensure adequate results from a survey that are meaningful and consistent with the data quality objectives for the survey.

So, thank you, Jack, for your question. And also thank you, Greg, for responding.

Any other questions or comments with respect to the questions we have on the screen now?

So, Jan has a question about the chat.

MS. BOUDART: And I'd also like to say that my comments apply to No. 7 on this discussion --

the list of discussion questions.

MR. KLUKAN: Thank you, Jan, for that comment. Again, we appreciate it.

You should be able to -- if you want to save a copy of the chat for yourself, you should be able to kind of -- if you're using Teams, just select all of the comments and copy and paste them out.

They are saved along with the video that Cynthia will be posting. And, Cynthia, correct me if I'm wrong about that.

So, to address the comment about saving the chat, generally speaking that is saved along with the video with it. You get the whole Teams screen, if you will, in the video that is saved.

MS. BARR: No, we do not have the chat saved.

MR. KLUKAN: Oh. Never mind then.

MS. BARR: The video is saved, but I do agree with your comment that this chat is available for anybody to copy and paste manually.

It's just not a feature that is offered in Microsoft Teams, but we are reading most of the chat questions which will be in the video recording which will be posted, and I also do a meeting summary where I summarize major chat comments that maybe we didn't

discuss.

So, you will have other opportunities as well as copying it out of the chat to save the information from the chat questions. So, thank you. Hopefully that answers your question.

MR. KLUKAN: It does. And thank you for correcting me and not letting me state very wrong information. So, I appreciate that. I don't know why I thought that.

Anyway, Jack has posted a comment and thank you, Jack: Can we use a separate meeting on adequate scan MDC -- or I think you're asking can we have a separate meeting on adequate scan MDC and investigation levels for DRP? So, thank you for that comment, Jack.

Sarah has put up the discussion period -- or discussion -- next set of questions and these relate to exposure scenario questions.

And, again, I'm going to read these out loud for the benefit of those participating on the phone, as I did for the last set of questions.

And so, who are the potentially exposed individuals?

No. 2, how do you determine the likelihood of interaction with a particle?

And No. 3, what are the risk-significant exposure pathways for DRPs?

And, Leah, if I am not mistaken, you had a fourth question that you wanted to add onto this as well?

MS. PARKS: I believe that we already have discussed that question, which is what is the dose limit. So -- but we can discuss that now, too.

MR. KLUKAN: Alright. Thanks, Leah. I appreciate it.

So, if you have a comment on any of those three questions that are now up on the screen, please feel free to unmute yourself or to raise your hand within Teams or to press *5 if you are participating via phone.

And, Boby, you have your hand up. So, feel free whenever you are ready.

MR. ABU-EID: Yes, thank you.

I think the first question is regarding the assumption by the licensee about the land use. What is the land going to be used where the contamination is?

So, that's very important question that we need to deal with before anything in order to establish acceptable exposure scenarios.

And that's what we will review, how the land is going to be used. Is it going to be used for agricultural purpose? Somebody is going to cultivate the land? And then as you till the soil -- because this is -- depends on this kind of activity.

Or is going to be used for building another building? And then this means that maybe the scenario for exposure is different.

So, in my view, we need to address that issue before you answer that question. It's up to the licensee to propose what is the reasonably foreseeable land use for the next 100 years.

MR. KLUKAN: Thank you very much, Boby, for those comments.

Next, we're going to go to Michel Lee. I have allowed your microphone, so please feel free to unmute yourself whenever you are ready.

So, Michel, I have made you --

MS. LEE: Oh, I got it.

MR. KLUKAN: There you go.

MS. LEE: Yeah. The little thing wouldn't click.

You know, this has been incredibly informative and I just sort of want to circle back to the comments that I made, but also that Paul Blanch

made early in the meeting and just throw out a thought not really for an answer, but just for a thought, you know, food for thought.

There's obviously tremendous effort being made to try to figure out what the potential risks are for these really, really hard-to-find particles that, you know, talk about a needle in a haystack.

But if there is some level of confidence that the surface of a site is relatively, you know, can be relatively classified and, you know, identified and the real issue may be the buried -- the deeply buried components that are going to be going deeper, deeper, deeper into the soil and some future, you know, housing contractor for, you know, low-income communities and their children to move in, you know, lots of demolition and excavation, that maybe as an overall cost benefit issue somebody ought to be thinking about, you know, lots of the focus on what's being focused on not that it's not good and we should have research and so forth, but more perhaps a change in how these sites are used in the future and that they should -- that there's some value to be had about leaving plants alone.

And there might be -- even be a social cost benefit that can be put into the calculus with

communities being paid to just essentially let nature take its course and less money being spent on trying to figure out how to find a DRP. That's it.

MR. KLUKAN: Alright. Well, thank you, Michel. We appreciate that comment and that suggestion. So, thank you very much and thank you for participating today.

Others? Any comments or thoughts with respect to these questions that we have up on the screen?

And again, those are, No. 1, who are the potentially exposed individuals?

No. 2, how do you determine the likelihood of interaction with the particle?

And No. 3, what are the risk-significant exposure pathways for DRPs?

Jan, it looks like you have your hand up. So, please feel free whenever you are ready.

MS. BOUDART: The third question is very intriguing because the risk-significant exposure pathways have been showing up all over the country.

And I know this is supposed to be about decommissioning nuclear power plants, I think, and the DRPs, and I'm especially concerned about Zion, but there are -- there are pockets of people who have been

exposed to particles.

And I'm thinking of the one in St. Louis and of the Coldwater Creek that was recently flooded and the school -- the Jana Elementary School was closed and the children had to go someplace else and this risk-significant exposure pathway was Coldwater Creek. So, that's what that question made me think of.

MR. KLUKAN: Well, thank you for sharing that thought with us, Jan. We appreciate it.

Any others on these questions? If not, Sarah, I -- there we go. Thank you.

MS. LOPAS: The last set.

MR. KLUKAN: Our last set of questions. And, again, you know, please let me know if there's anyone in the room who would like to comment on these. I will read these out loud. There are two sets of questions.

There is, first, the general questions. Of the general questions there are four: Should likelihood of exposure be considered as part of the decision-making process, (e.g., potentially considered as a less likely but plausible scenario)?

No. 2, is there a DRP activity level below which there is no concern for license termination?

No. 3, what other actions should licensees

take during decommissioning to limit releases to the environment?

And No. 4 of the general questions, if DRPs are present below a scannable depth (e.g., below surface soil), what actions can a licensee take to demonstrate that there are no subsurface DRPs of concern present?

And then the second set of questions, as shown on the current slide, with respect to RCD/dose conversion factor questions, No. 1, should DRP dose conversion factors for different age groups or sensitive age groups be developed?

No. 2, what should DRP exposure time be based on (external and internal)(e.g., how long does a DRP remain on the skin)?

No. 3, are there other methods for development of DRP DCFs that should be considered besides the ones discussed today?

And finally, are there other radionuclides associated with DRPs that should be considered besides the ones discussed today?

And with that, if you have any questions, please feel -- or comments, excuse me, please feel free to raise your hand or press *5 on your phone.

Jack has asked the question: Has

probability been calculated/determined of the likelihood of interaction with a DRP on a 100-plus acre site?

And, again, the question is: Has a probability been calculated/determined of the likelihood of interaction with a DRP on a 100-plus acre site?

MS. LOPAS: Greg, do you need me to reread that? Turn on your mic and I'll reread it. So, has the probability been calculated/determined of the likelihood of interaction with a DRP on a 100-plus acre site?

MR. CHAPMAN: Typically, and Leah can correct me if I'm wrong, but we assume probability of interaction being basically 100 percent and that's how we assess the dose in that case.

And so, even though qualitatively we can say it's a very remote probability, it's -- the dose has to be minimal as well or within reason as determined on a case-by-case basis.

MS. LOPAS: Greg, I think the question was maybe not how we do it or what we would allow, but do you have any knowledge of anyone trying to assess the likelihood of exposure to a DRP based on even international experience?

MS. PARKS: So, for the Shelwell case there was a probability that was calculated for that. And the public is welcome to peruse any docketed information that is publicly available on sites where probabilities have been calculated or estimated.

MS. LOPAS: Alright. Thank you, Leah.

And, Bruce, did you want to speak?

MR. MONTGOMERY: Yeah. Thank you, Cynthia.

I think I should just take a shot at general question No. 3 on what other actions should licensees take during decommissioning to limit releases to the environment.

I think that question is really asking about DRPs during decommissioning and that's especially relevant during the -- in the current era where accelerated decommissioning has become vogue when we start decommissioning activities almost immediately after cessation of operations so that we can get these sites released for unrestricted use as soon as we possibly can.

We do that accelerated decommissioning because we think it's important for the sustainability of this energy industry, but, in so doing, I think we've learned some lessons.

No. 1 is, wherever possible if we're dismantling contaminated structures and segmenting equipment like reactor vessel internals, just make sure that we have sufficient containment with negative ventilation systems are running.

When we start taking large structures down like a containment building, let's use tenting and some sort of cover as much as possible.

Minimize dose by spraying water on the areas that we're turning concrete into rubble to minimize the likelihood that anything is going to migrate from the immediate vicinity and then making sure that that entire vicinity is cleaned up or remediated before its release so -- or even surveyed.

So, a lot of work is happening right now at the sites that are either into dismantling or preparing to that are benefitting from the lessons we've learned over the past few years, not to mention the lessons from the last couple of decades with the sites we've already talked about here today, but we continue to learn and hopefully we'll get to the point where DRPs are something we've talked about and we've come up with methods to deal with, but don't have to deal with them in the field.

I would like to add one question, though,

and that is -- in this category, is if we do suspect from the historical site survey from the operational period that there might be discrete radioactive particles onsite, we should have a discussion at some point either within the industry or with the NRC staff, what sort of expectation would we have or want to have for the information that goes into the license termination plan in terms of scanning pathways, dosimetry and so forth when that's submitted, because then otherwise it just becomes an issue that comes up during the final status survey reports and reviews and we might not be as well prepared for that if we hadn't really documented what our plans were as part of the license termination plan proper. End of comment.

MS. LOPAS: Okay. Thank you, Bruce.

And, Eric, we'll go next to you.

MR. DAROIS: Yes. Thank you, Sarah.

I'd like to just comment on Item 2 under general. And that's in regards to kind of a DRP activity level below which this shouldn't be any concern.

I think it's -- I mean, we've heard a lot and learned a lot about the different dose modalities for particles whether it's respiratory tract or GI tract.

And it's obviously a bit complicated from a regulatory point of view to pick one or several of those parameters to say, you know, here's the dose, here's the profile that we're looking for.

But ultimately if we do that, we informed with the dose, whether it's 25 gray or something else, that's going to allow us to calculate an activity below which we don't care a lot about. That will also drive our MDAs.

Up until now, we haven't had that, you know. The MDAs are let's go as low as we can. I mean, that's fine, but it should be intimately tied to the dose significance.

And if it's 25 gray, then, I don't know, is it 5 microcuries, 10 microcuries, 1 microcurie? And if it is, then I'm guessing that most of the standard survey methodology would be adequate the way it existed before this discussion for sensitivity.

But, you know, we all know that right now, but I think that should be the goal is to define the activity levels maybe by nuclide that we would need to demonstrate adequate MDAs against, you know, and maybe at the end of the day this becomes less of an issue because of that. So, that's my only comment. Thank you.

MS. LOPAS: Okay. Brett, I will hand it back to you to see if there's any questions on -- in the chat or raised hands.

You're muted, Brett.

MR. KLUKAN: I unmuted. Well, there we go. So, alright. We do have some questions in the chat.

So, Louis asked: Regarding DRPs, is the regulatory guidance clear on how hard a licensee has to look or prove or disprove DRPs onsite if site history classification data does not identify DRPs onsite?

And then I don't think that we have responded to that yet. So, I will open it up to the NRC staff if they have any response.

MR. CHAPMAN: Yes. Unfortunately, there isn't any clear NRC guidance with regards to DRPs and scanning at this point in time. So, it's something we're hoping to develop in the process here.

MR. KLUKAN: Thank you, Greg.

Next we have from Don Mayer: What specifically has the NRC considered to address the absence of non-stochastic limit -- or non-stochastic limit in Part 20 subpart e for DRP doses during decommissioning? The dose limit chosen is very

germane, if not critical, to MDAs, detector selection, etcetera, etcetera.

And, yeah, I will read that out loud one more time because I think I read it kind of quickly: What specifically has NRC considered to address the absence of a non-stochastic limit in Part 20 subpart e for DRP doses during decommissioning? The dose limit chosen is very germane, if not critical, to MDAs, detector selection and etcetera.

And, again, thank you, Don, for that question.

MR. CHAPMAN: Obviously, we're considering things. We've presented some of the things we're considering today.

However, we have to be very careful in that because it's very possible that it will go over into a policy decision.

And so, we can strive to get something, but it's likely to push into the policy.

MR. KLUKAN: And, Don, I just wanted to highlight your second comment that Eric essentially asked the same question: A priority MDA could or should be risk/dose-informed. So, thank you again, Don.

We then have a comment from Jack:

Isolation and controls, including very strict controls, for the storage of potentially or actually radioactive material in areas that have completed FFS and/or IVC cannot be overestimated in preventing recontamination.

And I'll read that again for those of you participating on the phone. So, the comment is: Isolation and controls, including very strict controls, for the storage of potentially or actual radioactive material in areas that a completed FFS and/or IVC cannot be overestimated in preventing recontamination.

So, thank you for that comment, Jack. And, again, if you'd like to make a comment on any of these questions or anything else we've previously discussed, please feel free to put it in chat or raise your hand within the Teams app or Teams browser or press *5 if participating via phone. Again, that is *5.

Jack has further added as a comment: We need a definition of what "no subsurface DRPs of concern" mean.

And, again, that comment is: We need a definition of what "no subsurface DRPs of concern" means. So, thank you, Jack.

And, again, I know I've said this a lot in this meeting, probably sounding like a broken record, but if you want to ask a question, please feel free to raise your hand within Teams or the Teams browser or press *5 on your phone. Again, that is *5 on your phone or enter in your question or comment into chat.

MS. LOPAS: Yes. Thanks, Brett -- oh, looks like Boby raised his hand and then lowered it.

MR. ABU-EID: Yeah, this is Boby.

I will start with part No. 2 and the question is definitely very clear based on site history whether there would be subsurface contamination or not.

And I think sampling and looking at the trend and site history will tell you and you need to have some kind -- if there is suspicion that there is subsurface contamination, need to do sampling, monitoring those, and try to sample.

That part definitely we need to confirm if you have suspicion that there is subsurface contamination.

The other part that is definitely in decommissioning normally for demolishing before demolishing a structure or a building, you need to make sure that, you know, that complies with the

surface contamination.

We have those assessments actually specific kind of those analysis for surface contamination of local contamination before demolishing and say, okay, it's clean.

Try to make sure that until decontaminated completely and was approved that if it's clean and then you will decommission the facility.

Otherwise, maybe we do not know if there is contamination or not and then we try to demolish the building and we are mixing everything together and here we are, we are dealing with the problem.

MR. KLUKAN: Thank you for that comment, Boby.

At this time, I am not seeing any additional hands raised or comments or questions in the chat.

So, Sarah, I will turn it back over to you.

MS. LOPAS: Okay. And thank you, Brett. Thank you very much. And before I hand it to Chris McKenney to close this out, I just want to double-check with NEI if there are any last statements.

MR. MONTGOMERY: Yeah. Thank you. Bruce Montgomery, NEI.

I would just like to make a comment that after listening to the technical presentations today, I can't help but conclude that we know a lot more about DRPs than we don't know as far as our ability to find them, what they look like, how we might encounter them in the body and what their health effects might be medically.

So, I think a lot of the questions that are written down here for the discussion period and some of the questions that have come up during this call and this meeting, some of these probably do deserve a policy answer.

You may never be able to answer these things technically, but certainly they deserve dialog and we'd be more than happy at NEI to work with the NRC staff to propose solutions technically where they're needed and then policy-wise because it's very important for us to be able to get back into the field and do the work we need to do to complete the decommissioning of these sites in a manner that assures public health and safety. So, thank you.

I would like to just thank Jane Marshall and Cynthia and Chris and their team for all the work that was done to bring all this information to the table today. It was very impressive.

I've learned a tremendous amount and I'm very encouraged that -- more than ever that we have a pathway to coming up with a regulatory framework that works in this area. So, thank you very much.

MS. LOPAS: Thank you, Bruce.

Alright. And now I will hand it over to Chris to close us out.

MR. MCKENNEY: Yes. First, I want to clarify one thing, which is the building surface contamination concentration levels we have like in our guidance and stuff is for -- they're only clean after license termination and not to be used during the middle of decommissioning as a factor of that they are clean at that point.

Because they are related to the actual decision for license termination at 25 millirem, and so that would be our approval system much like we did the Trojan Power Plant.

Again, my name is Chris McKenney. I am the branch chief for the Risk and Technical Analysis Branch.

And so, again, Bruce took a lot of statements out about the fact that we have learned a lot, put out a lot getting everybody up to speed from all these different areas about, you know, we dove

quite deep into, you know, dosimetry and into scanning and, you know, not everybody is an expert in those areas.

And so, it may have been a little deep waters at times, but -- to try to swim there, but I think that we are moving forward, we are trying to get that and make it a clear path forward.

Go from the whole way of, you know, every licensee has different processes and a different site history and they've got to take that into account as to how they're going to reach license termination whether you're a medical facility all the way to a power reactor. And even a power reactor next-door that was a different model, that is going to be different than you, for some reason.

So, the -- but we need to be able to establish a predictable approach in the guidance in the process and so that the members of the public, the licensees and the regulatory staff, all are working from the same concepts to demonstrate that the members of the public in the future will be protected after the licensee leaves the area and they can literally use it for unrestricted use.

Obviously, we have an approach for restricted release, and we've also had some situations

where because we had extremely definite plans right after termination for, like, the Rancho Seco site which immediately repowered as another power plant, that they had both industrial uses and, for a short period of time assumed -- and then they assumed a full unrestricted release after that because they did have some seriously definitive plans.

But that's where -- why the regulation is allowed to be -- is designed to be site-specific, risk-informed. Everybody has a different history. Everybody has different radionuclides.

But at the end of the day, we're trying to keep the risk to the public minimal and appropriate underneath the public dose limit and clear guidance will assist everybody in that endeavor.

So, thank you all for attending whether it's virtually or in-person. And after this, we will be posting all of the records to the meeting to the public website and continuing on the process.

We should be getting a tracking page on what's new in decommissioning on our website. As to the next steps whether we have future meetings or other documents, are available like the document on dosimetry that we'll be posting.

So, the webpage on our website of what's

new in decommissioning is a way you can stay informed of where we are in the process. Thank you.

MS. LOPAS: Thank you, Chris. And Cynthia is putting that website in the chat again for you all. And if you're not on the chat and you're just on the phone, I believe you can just probably Google what's new in decommissioning, NRC, and it will probably pop right up for you. Good old Google.

Alright. With that, I want to thank all the attendees and all the participants for their great presentations and everybody's comments and questions.

And I believe if you have extra additional questions or comments, you can get in touch with Cynthia Barr or Greg Chapman. And with that, we will close out today's meeting. Have a great rest of the afternoon. Thank you.

(Whereupon, the above-entitled matter went off the record at 3:48 p.m.)