THE U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
PUBLIC HEALTH SERVICE
CENTERS FOR DISEASE CONTROL AND PREVENTION
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH

convenes the

WORKGROUP MEETING

ADVISORY BOARD ON

RADIATION AND WORKER HEALTH

The verbatim transcript of the Meeting of the Advisory Board on Radiation and Worker Health Workgroup held in Cincinnati, Ohio, on Aug. 4, 2005.

C O N T E N T S

Aug. 4, 2005

TRANSCRIPT LEGEND

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-- (sic) denotes an incorrect usage or pronunciation of a word which is transcribed in its original form as reported.

-- (phonetically) indicates a phonetic spelling of the word if no confirmation of the correct spelling is available.

-- "uh-huh" represents an affirmative response, and "uh-uh" represents a negative response.

-- "*" denotes a spelling based on phonetics, without reference available.

-- (inaudible)/ (unintelligible) signifies speaker failure, usually failure to use a microphone.

In the following transcript (off microphone) refers to microphone malfunction or speaker's neglect to depress "on" button.

P A R T I C I P A N T S
(In Alphabetical Order)

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BEHLING, HANS, SC&A
BLOOM, CINDY, MJW
BROCK, DENISE, UNWW
CASE, DIANE, DOL
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GUIDO, JOSEPH, MJW
HOMOKI-TITUS, LIZ, HHS/OGC
HOWELL, EMILY, HHS/OGC
KATZ, TED, NIOSH

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LIPSZTEIN, JOYCE, SC&A
MAKHIJANI, ARJUN, SC&A
MAURO, JOHN, SC&A
MILLER, RICHARD, GAP
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SAMSON, BOB, GAO
SHEFFITS, SANDRA, GAO
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STAFF/VENDORS

LASHAWN SHIELDS, Committee Management Specialist, NIOSH
STEVEN RAY GREEN, Certified Merit Court Reporter
JONICA MUELLER, Certified Court Reporter

P R O C E E D I N G S

(9:30 a.m.)

(Technical difficulties occasionally rendered portions of comments made by a speaker unintelligible. Those portions are noted as such.)

DR. WADE: With apologies for the lateness of the hour in terms of getting started, but we had technical difficulties, this is Lew Wade. I work for NIOSH. I also serve as the Designated Federal Official of the Advisory Board on Radiation and Worker Health.

This is a working group meeting of the Advisory Board. This working group meeting specifically is looking at issues related to the Mallinckrodt site profile and the review of that site profile by the Board and the Board's contractor, SC&A.

I would also remind all of you that there is also an SEC petition before the Board that relates to workers at Mallinckrodt. This working group is looking specifically at the site profile, but clearly there are interactions between the two processes as they go on.

The Board asked this working group to get together and it also asked that we conduct the working group meeting as a public meeting, so we've noticed this working group meeting. The public has been invited. There will be no public comment period scheduled during this working group meeting. The public is allowed to listen to these deliberations.

The Board did make it a point to say that the petitioners involved in the Mallinckrodt SEC petition be invited to participate fully in this working group, and I see that Denise Brock is with us. Denise, you only need to let us know of your interest to speak at any point and you can speak. You're also welcome at the table, but I think you're more comfortable -- at least you identified you're more comfortable where you are.

The working group that has been put together for this consists of Dr. Melius, Mark Griffon, Wanda and Mike Gibson, who is not here.

MR. GIBSON: I'm on the phone.

DR. WADE: Oh, Mark -- Mike is with us. Welcome.

It is important that in the conduct of this

business there not be a quorum of the Board present, so I would certainly ask when we go around that all Board members identify themselves so that we can police this action relative to there being a quorum. A quorum would be six or more Board members. I'm operating on the assumption that we will not have that quorum.

Now Ray Green could not be with us to -- to transcribe and produce minutes of this, but his colleague, Jonica Mueller, is with us and will ably fill in for Ray.

I don't think there's anything else other than for us to go around and identify ourselves. I would certainly ask that any Board member, any representative of SC&A, any representative of the Federal government identify themselves. Members of the public are free to identify themselves or not, as they see fit. But again, it is terribly important that any Board member identify themself, so let's go around this table. Then we'll do the people in this room, then we'll do the people on the telephone.

Again, my name is Lew Wade. I work for NIOSH and serve the Advisory Board.

MR. GRIFFON: Mark Griffon, member of the Advisory Board.
MS. MUNN: Wanda Munn, Advisory Board member.
DR. MAKHIJANI: Arjun Makhijani, SC&A.
DR. NETON: Jim Neton, NIOSH.
MR. GUIDO: Joe Guido, MJW.
MS. BLOOM: Cindy Bloom with the ORAU team, also MJW.
MR. ALLEN: Dave Allen with NIOSH.
DR. MAURO: John Mauro with Sanford Cohen & Associates.
DR. MELIUS: Jim Melius, Board member.
DR. WADE: Anyone in the audience who would like to identify themselves? Denise, would you please? I believe you have to do -- okay, thank you.
Now on the telephone, in no particular order, let's start with any Board members present.
MR. GIBSON: Mike Gibson, member of the Advisory Board.
DR. WADE: Thank you, Mike. Any other Board members present?
(No responses)
Representatives of SC&A?
DR. BEHLING: Hans Behling, SC&A.

DR. WADE: Anyone else from SC&A?
DR. BEHLING: I believe Joyce Lipsztein was going to phone in and she'll join us later. She must have disconnected, but she said that she will be calling back in a matter of minutes. She was on the phone around 9:30.
DR. WADE: Thank you. NIOSH or its contractors?
MR. TAULBEE: This is Tim Taulbee with NIOSH.
DR. WADE: Anyone else, NIOSH or its contractors?
(No responses)
Any other employees of the Federal government.
MR. KOTSCH: This is Jeff Kotsch with the Department of Labor back in Washington.
DR. WADE: Thank you.
MS. CASE: And Diane Case, as well, Department of Labor.
DR. WADE: Thank you.
MR. SAMSON: This is Bob Samson from GAO, also in Washington.
DR. WADE: Welcome, Bob.
MS. SHEFFITS*: And Sandra Sheffits with the GAO in Chicago.
DR. WADE: Any other representatives of the

Federal government?

(No responses)

Anyone else who would like to identify themselves?

MR. MILLER: Richard Miller of the Government Accountability Project.

DR. WADE: Welcome, Richard. Anyone else?

(No responses)

Okay, before I turn it over to Mark, just to sort of put this in context, the Board had laid out a very specific procedure for this working group to follow. It included the working group meeting sometime between July 31st and August 8th. This is that meeting.

There is the expectation that SC&A would review the NIOSH materials presented at this meeting and would prepare a response to the Board by August the 16th in anticipation of the Board meeting scheduled for the end of August.

Mark, those are all the introductory comments I have. Please...

MR. GRIFFON: My -- my piece here'll be pretty short, Jim. I -- I think we should -- we passed around -- I don't know if you got a copy of this, Denise, but it's the document

generated at the last Board meeting -- the priority issues for demonstrating feasibility of dose reconstruction for Mallinckrodt. And there's a list of tasks, and I thought that probably the best way to work through this is to start on this list of tasks and have NIOSH present their materials for each item. And maybe, if it's okay with -- with -- with NIOSH, with Jim, I think we'd like to keep it fairly informal so that we can break in with questions during your presentation instead of holding them off until the end or something. I think it'd be better -- I think it would, you know, be more workable if we could just interact while you're presenting. So if that's okay, I'll turn it over to Jim and let you start with number one.

DR. NETON: Okay, thanks -- thanks, Mark. I -- I really -- since this was in the format of a working group, I really did not prepare any official Power Point type presentations, but I'd just like to continue on the conversation we had at the last working group meeting which was held by telephone. I think it was -- time -- time flies. I think it was last week, some

-- somewhere thereabouts.

Since that -- that meeting, we have distributed a number of what we're calling our -- our in-process work products and, you know, we -- we sent them to the Board and other interested parties as -- as they were available, so hopefully folks have had a chance to look at those documents and formulate some -- some rough opinion as to whether they're in agreement or disagreement with -- with where we're headed.

The first -- the first issue on the table is under item 1(a), the handling of raffinate exposures where NIOSH has specified the radionuclide ratios for ore processing, including non-pitchblende ores. That was substantially covered, to a large extent, in the document that was distributed entitled -- let me see if I can -- yeah, it was a 23-page document. It was entitled "Dose Reconstruction Approach for Mallinckrodt Uranium Process Residues".

DR. WADE: And we have copies of all these documents if anyone requires them.

DR. NETON: Yeah, there are copies at the back

table available for members of the public and I have brought extra copies of everything for people at the -- at the working group table if they don't have them with them.

Let me just see -- I also have it on my laptop here. I can bring it up if we get to any specific sections that people want to discuss. What was the title of that again, Wanda, "Dose Reconstruction Approach" -- I made -- okay, I made a PDF file out of it, that's where it is. Okay, I'll just bring that up and -- there is a slightly revised version of this that you don't have, but -- but in essence it was just corrections of some typographical errors and that sort of thing, which did not change any of the -- substantially any of the technical content.

But in that document I think you would have seen that our approach at -- at this time is to rely on the radon breath data for workers to establish the radium intakes for workers. And then subsequent to radium in the decay series, we would apply the ratios that were observed in the K-65 material stored in Silo One at the Fernald site. There is some -- some discussion

in the document that we distributed that -- that leads us to believe that that material is -- is representative -- it is the material that was collected at Mallinckrodt, whether it came from Mallinckrodt directly to Fernald or via a temporary storage at the Lake Ontario Ordnance Works, they are actually the K-65 materials that were collected. You know, we're not stating that the absolute concentrations are to be used, but really we're relying on the ratios of the progeny in those -- in those materials, in the K-65.

But to take a step backwards again, we are -- rather than using the ratio that was proposed of 100 to one in the profile to bracket the radium to uranium ratio for workers with K-65 material, we have gone through -- evaluated the data and we believe that the radium breath data provide more realistic bounding values for intakes of radium at the site than applying a ratio of 100 to one. There's a couple of reasons for this, and I'll just throw this out here and we can open it up for discussion, I suppose.

But the -- it became obvious in looking at many

of these dose reconstructions -- not many, you know, looking at the dose reconstructions that the workers themselves were not only exposed to K-65 material. So you know, it would be inappropriate, for instance, to have a worker who -- who worked with uranium -- pure uranium materials and then K-65, to apply this 100 to one ratio because many workers were rotated throughout the plant in the attempt to keep the -- their exposures below certain standards, and the K-65 material had very high -- high dose rates so the workers were rotated through. So we -- we believe that just taking the uranium intake for a worker and then multiplying it times 100 results in fairly -- fairly substantial intakes that are actually not borne out by looking at the air monitoring data themselves.

For example, if you look at an intake of a worker using bioassay data, in the first one -- and Joe Guido will talk about this later -- his intake in picocuries per day actually about equals what the intake was predicted based on air sample data, within -- within the realm of what I showed at the last Board meeting, that -

- you know, the air sample data somewhat indicates that possibly the person had no K-65 exposure at all. So to take that intake, which is -- which is equivalent to the K-6-- which is equivalent to the air monitoring data and then increase it by a factor of 100 for the radium progeny puts it above where you would expect any intakes from U in the in-plant air monitoring data. So that's one reason.

The second reason, more importantly I think, is that the K-65 -- the radon breath data are more -- we believe to be more representative of reality. It's a -- it's a bioassay measurement taken on an individual. It's not reliant upon air concentration data. So that's where we're at with that.

Now we would propose, however, once you get the radium intakes based on the K-6-- based on the radium breath, then we still need to apply the dose fractions from the progeny below radium. And those fractions would be based on the ratio of radium to progeny in the K-65 material at Fernald. So that's where we're at.

It's open to discussion, I suppose.

DR. MAURO: This is John Mauro. First of all,

I really appreciate all the material that you provided to us prior to this meeting, and Arjun and I and the other folks on the line, Joyce and Hans, have all had an opportunity to fairly quickly run through the material within the context of all the material that came before. It's been extremely helpful and I really appreciate the incredible amount of work that went in.

What -- what we have been doing is caucusing over the past several days and formulating, certainly just as (unintelligible) in a situation where they're still formulating and finalizing (unintelligible) and we're doing the same. And there are a number of areas where I think that, for the purpose of this meeting, it would be helpful to make a distinction between those areas where you have laid out a strategy for coming to grips with what I would call site profile type questions. Here we have certain data -- in fact, here we have lots of data, and here's how we plan on prioritizing or combining and using and -- these data in order to do the dose reconstruction for a particular worker where you may have some missing data.

My initial impression -- and I'm going to work through -- I'm -- these are really by way of introductory remarks and (unintelligible) to Arjun, who's really been our point man, to help in an appropriate way to start to engage some of these issues as we move through them. So I thought it'd be worthwhile, if it's acceptable to the Board, that as we move through the processes we could (unintelligible) -- could communicate our initial impressions and the things that we've been thinking about, with the objective of forwarding the process so we're as mature down the road as we can as we approach the end of August.

One of the things that I think might be very helpful today is as we go over some of our observations and thoughts on some of the matters, such as the ones you just described, it might be important -- to the degree we can -- to parse between those areas where our concern is with the data itself and its adequacy, because we recognize that the data itself and its ability to completely characterize or to be useful as a surrogate or as a cohort data for the purpose of dose

reconstruction, that goes toward issues that are of concern from an SEC point of view -- we recognize that's part of what's on the table here -- and those items that lean more toward what I call site profile issues where you might -- where you may have lots of data, but we may have certain questions as to how you would use that data in the -- in the most claimant-favorable optimal way.

So what we would like to do, and I'm going to I guess leave it to everyone around the table, when would it be appropriate for SC&A to say okay (unintelligible) -- for example, put forward certain ideas and strategies where we sort of come out right now and our thinking on it so that is a -- that is a prerequisite. I'm going to ask Arjun, and certainly the folks that are on the phone, which I believe is Joyce and Hans, Joyce looking mainly at the internal dosimetry issue, the radon issue, the raffinate issues and the strategies that you are engaging in, and Hans looking more toward some of the external dosimetry issues as being the areas where (unintelligible) us communicating to you our initial impressions so that we can move on

from there.

So with that said, I guess -- Arjun, at this point if there's anything that you want to bring in or -- or I didn't want to interfere --

MR. GRIFFON: No, no, no.

DR. MAURO: When I get this dialogue, I (unintelligible).

MR. GRIFFON: Yeah, I mean I -- I expect this to be pretty informal, so as you have comments I think just bring them in and bring your general opinion of a certain issue any time -- you know, any time it comes up. I mean let's just have a form-- informal discussion. I mean I -- I was going to ask, you know, Jim, that -- that covers number one. But if we start to go down 1(a), (b), (c) --

DR. NETON: Right.

MR. GRIFFON: -- I think we'll -- we'll pull out some of these details that -- that we know are in this report. And I think most -- mostly what we discuss in this report, you know --

DR. NETON: Yeah, sure.

MR. GRIFFON: -- go down these questions, so Denise has a comment, though.

MS. BROCK: (Off microphone) I have a question

already and I don't want to bog everybody down. I feel funny asking questions but sometimes I just don't understand (unintelligible) and I can't tell (unintelligible) that's why I'm confused (unintelligible) daily weighted averages (unintelligible) going to use the daily weighted averages (unintelligible) radon (unintelligible) things right.

DR. NETON: Right, the daily weighted average values are the air sample data that were collected in the campaigns on a yearly basis, usually over a couple of month period. We believe that the radon breath data are a better indicator of the intake of radium for the worker than relying solely on the daily weighted average.

MS. BROCK: Isn't that a little bit different than what you had previously thought at the last meeting?

DR. NETON: That's true. That's true that we -- we had proposed, as a -- as a bracketing measure, we would rely on the daily weighted averages. Those still are there. We don't believe them to be totally unreliable. We just believe that this approach is -- is a better --

a bit more refined estimate.

MS. BROCK: Then I guess I'm -- I wanted to ask about the SEC evaluation then. Is that a living document as well as the site profile? I mean can it be --

DR. NETON: I believe Larry or Lew could --

MS. BROCK: -- altered and changed like this?

DR. NETON: That's more of a --

DR. WADE: (Unintelligible) speak to that?

MR. GRIFFON: Larry.

MR. ELLIOTT: The -- as -- as you know, Denise, we have provided supplements in response to issues raised during Board deliberations on the evaluation report. And I would see that in this case we will add another supplement responding to, again, another set of issues that have been raised. So is it a living document? This is a deliberation process that the Board is engaged in. And as we proceed through that, the evaluation report will have to be reflective of that process. I don't know that we have envisioned evaluation reports to be living documents, as we speak about site profiles being living documents, because as we work through dose reconstruction we identify

improvements to methodologies, data information, the site profiles do change. The evaluation reports are different in that as soon as a determination is made about a petition, then that establishes the conclusion of the evaluation. Does that help you understand?

MS. BROCK: I -- I understand what you are saying, but I'm perplexed because I -- my thought, and I believe the claimants' thought at the last meeting, was that NIOSH was going to use the daily weighted average and basically the proof is in the pudding, you can use the daily weighted average. And then I'm wondering what caused you to eliminate that. I know you feel the breath radon is more reliable, but isn't there only a minimal amount of claimants that actually had breath radon? I mean how reliable is that?

DR. NETON: Well, we -- we estimate around 20 percent of the cases that we have in our possession where people worked during the raffinate period have radon breath data. We've looked at the files, and each -- each person who has radon breath data, and we have radon

breath data for 2,500 individual measurements, each -- each measurement is -- not all of them, but almost all of them are labeled with the job category, title, some indications of what the process was that the worker was involved -- what the worker was involved in. They are almost exclusively -- not exclusively, but to a large extent related to raffinate type workers, people who worked in Plant 6 with radium-bearing materials. But we believe that the samples that were taken were taken on the target population that were potentially exposed. I've looked personally through the files of the cases we have that are not -- do not have radon breath data. Many of them are workers such as administrative folks, security folks, forklift operators. One could argue whether that should have been monitored or not, but it makes some sense to us, looking at the files, of who was monitored for radon breath and why. And there are actually internal HASL -- letters to HASL back and forth discussing, you know, which -- which types of workers would be monitored and put on the monitoring program.

MR. ELLIOTT: I think it's important for us all

to recall, if your question comes from the perspective of your petition, that the class that you have petitioned for here is -- the petition is evaluated under our -- our rule, the SEC petitioning process rule. And in that rule we are required to demonstrate where we can do dose reconstruction by capping the dose. And the particular question at hand with regard to how we go about doing that, whether it's using breath radon or whether it's using time-weighted average air concentration data really goes to dose reconstruction. We've -- we have demonstrated, we feel, in our evaluation reports and the supplements to that original evaluation report we've been consistent in our commentary saying we feel we can reconstruct dose. And I think as we would have proceeded in doing dose reconstructions, we would have achieved some of these recognitions that Jim is bringing forward now as part of this deliberative process of the Board.

DR. NETON: I think this gets down to what John Mauro was talking about earlier, which is -- which is related to -- in an SEC evaluation one is -- one is trying to make the determination

can you bound the doses using -- you have sufficient data available to bound doses, and -- and that's one analysis.

Now when we get down into actually doing dose reconstructions where we are now, that's a slightly different issue as to how best to use the available data to make a more realistic determination of what the -- you know, what the individual doses are to work with. So that they're actually separate analyses. They really are.

MR. GRIFFON: Yes, but -- but -- but it is also important to note that -- I mean we went down this line of questioning for you to demonstrate that you could do it with your method at hand from the daily weighted averages. You were -- you were questioned by the Board to go back and look and give us specifics of how you were going to deal with the raffinate in terms of the daily weighted averages and -- and demonstrate to the Board that you could -- could cap the dose, bound the dose. And what -- the answer you came back with was a little bit --

DR. NETON: Right.

MR. GRIFFON: -- on the other side, so that -- that -- I think that's (unintelligible) --
DR. NETON: Yeah, I understand the (unintelligible) --
MS. BROCK: That's --
MR. GRIFFON: -- it seems like a -- I mean maybe you can still answer that first question, can you bound the dose with the air sampling. I think you're saying maybe --
MS. BLOOM: And maybe --
MR. GRIFFON: -- (unintelligible) we can, this is a better estimating technique I think is where you're going.
DR. NETON: I think that's what I'm saying is...
MS. BROCK: And that's exactly where I was going with that. It was my understanding, just as a lay person and somebody that petitioned this, that it was my understanding that you were going in front of the Board to show them that you could do it with a daily weighted average. And I personally don't really know -- I don't understand completely the difference between that, but I was curious what -- what specifically will not allow you to use that

daily weighted average. And as a petitioner I'm thinking to myself, since you haven't been able to do that and now you're switching gears -- at least in my mind that's what it looks like -- and you're trying something else, has this been validated? I mean how do we know that this is going to work and how do we know exactly if this is going to work or not. How do we -- how do we tell the difference and -- and I thought that we would be held to the daily weighted average, or you would be.

MS. BLOOM: Maybe -- maybe I could answer that. I was -- I'm Cindy Bloom and I was brought in at the last minute to answer that question.

Can you hear me if I turn my head?

(Off microphone) And when I started from the list of priority items to answer, and (unintelligible) the list that I read down and the first thing it said is can you tell me what's in the residue. And I'm going to call it the residue, the K-65 (unintelligible) not as raffinate but as K-65 or residue. And that's so (unintelligible). So first they answered that question. And as you look down

that list of questions you'll see that it says how are you going to do a dose reconstruction. And so I looked at all the data and I did look at the air data, and I did both a -- a fit of the tabulated data in the CER database and looked at the daily weighted averages there and I determined a geometric mean to those. I also looked at the maximum number or the maximum time-weighted average exposure in that dataset and I compared that to other (unintelligible) data. And some of that's in the -- in the report that we pulled together. Some of it may have been updated (unintelligible), but I did look at that part of the picture.

But then it (unintelligible) here's the breath radon and I looked at that, and we have a lot of breath radon data, and so I went that route and I said you know what, this number is making more sense.

I also looked at some of the workplace samples, which we don't have many, but we have one set of data from Mallinckrodt. We have data from another similar operation at (unintelligible) it's not a factor. Depends on (unintelligible) the radium measurement in air versus the

uranium measurement in air for the (unintelligible) cake operation at Mallinckrodt where they (unintelligible) residue sampling and where they were doing (unintelligible) and I looked at that and I looked at the ratios there, and they were more consistent -- the air sampling was more consistent with the breath radon ratios that we looked at -- the breath radon (unintelligible) radium 95th percentile, so it gets hard 'cause you're talking about these huge groups of data so I hope I'm making sense, but that fit with the air data that fit with what we were looking at in terms of that maximum daily weighted average. But if you applied the K-65 fraction itself from the (unintelligible) to -- let's see, we were actually doing it backwards to start to see if that was all radium. It doesn't make sense when you look at the workplace data and the other information, but you could do that and we've put some information together on that, as well. So we've looked at it all, but we're really trying to answer two questions. Can we bound the dose? I think so. Can we -- how are we going to do dose reconstruction? I think

that after looking at all the data that (unintelligible) clear to me that you would use the bioassay data and (unintelligible) 42 CFR (unintelligible) --

DR. NETON: 42.

MS. BLOOM: -- 42 -- 42. So it -- that says you'll use bioassay data as -- as your first piece of information, but you also look at everything else. So we've really taken the opportunity to look at all the data and (unintelligible) really tired (unintelligible).

MR. GRIFFON: Let me ask John to comment (unintelligible).

DR. MAURO: One of the impressions I got, and I would ask Arjun to develop it in a finer point, but it's a conceptual problem that we have. I understand -- you've created a series of what I call boxes whereby you have labels for job categories. You have labels for locations in buildings and facilities within buildings. And according to each of these designations, you have a fairly good idea of the types of activities that took place in each of these locations as a function of time. And on the basis of that, you could start to get a feel

for what datasets and information might be most useful for reconstructing doses -- I'll say internal doses in this case -- to workers who were in that location at that time. It's a very structured process and it's a -- it's very engineered and it's a -- it's almost -- it's almost like an assembly line. But when I read the documents I say that the lines -- when it comes to a real person now, and this is -- this is more of a conceptual problem -- I say okay, well, let's say we have a real person and we're trying to do a dose reconstruction for him. The problem is that that real person doesn't really fall into a given box. Not always, and maybe not often. That is, where he worked when, and certainly the feedback is not all that apparent. And so all of a sudden -- and -- and it's -- it's almost like a fuzzy view I'd have right now. I say to myself okay, I've got this person. I -- I know he did these kinds of jobs and might have been over here sometime and might have been over there, and then I layer in that fact that -- and I think of this in terms of bands. You have people that worked at certain times with the ore, maybe. And then

you have people that worked with different kinds of ore. Then you worked with the -- I guess the -- the first dissolution process. That is another band where you produce the K-65. Then there's another band of activities where maybe some different facility or a different time where the product that comes out is more of the short-lived progeny coming off the uranium. And then another band is where you're actually processing the recycled residue. So what I'm getting at is all of these are a flow that placing them in time and location and -- and marrying it back to a person. Then on top of that you have an array of data, lots of data, which is -- it's great, whereby you've got urine analysis with fluorometrics for uranium, you've got ratios that you have a handle on, at least for the radium to uranium that comes from the K-65. But then you've got these other ratios where you have these other short-lived radionuclides that come out of different bands in the process. What I'm getting at is -- and this is an impression initially obtaining and looking at the data.

(The reader should be aware that in addition to technical malfunctions in the telephone connections, there were other conversations taking place on the line at the same time the speaker was making his statement, which may have distorted the reporter's perception of what was being said.)

It's not -- it's going to be difficult to place a person (unintelligible) this person at this place and this time, and this is the situation. And on that basis, we think the radon breath analysis is the best way to get a handle on what his radium body burden may be, as opposed to going with his urine analysis and using some ratio, whether it's 100 to one or 400 to one, as we -- so what I'm getting at is that we have -- what I -- and this again -- stepping back and I would look to others in our group who've been looking at this a lot closer -- that the boundaries are not that clear, so that in practice, when you really have a real person that you want to do a real dose reconstruction for, you're going to run into the blurry lines between the different operations and activities that you're going to have a hard time coming to

grips with.

MS. BLOOM: John, I think we've looked at that and we've got some real cases to show you later to see how that plays out. I think that because of the way we do dose reconstruction on this project, the results are interesting. I think in general the coworker approach bounds things -- bounds doses, but we have individual data, we would use individual data first to address those kind of issues, and we'd use the other data to supplement it. But I think later, as we get into those cases, that would be a better time to -- to discuss that part of the process.

DR. NETON: Yeah, I think we're getting ahead a little bit on the issue. But if you look at the -- what was broken down for the internal dosimetry geometry calculations, 30 percent of -- 37 percent of the cases we have have job occupation listed as "operator". It's pretty easy to agree, I think, that those operators, if they worked in Plant 6, are covered with this K-65 raffinate exposure methodology. You've got another 20 percent that are trades and crafts, so about 57 percent of the workers,

in our minds, fall very easily into these categories where if -- lacking any specific evidence that they -- that they weren't exposed, that they would fall under the umbrella of this K-65 raffinate exposure approach.

That said, remember we have a large percentage --

UNIDENTIFIED: (On telephone) Hello?

DR. NETON: -- of workers have bioassay data. Hello? Is that Joyce?

DR. LIPSZTEIN: Hello?

DR. NETON: Yeah. Joyce, this is Jim Neton. How are you? I don't think she can hear us. Well, anyway, I was just going to say -- and so, you know, we propose -- and we'll get into this -- that we're going to apply this to a fairly large percentage of the workers and use a more -- a broader brush than -- than you would think because, again, if we don't have the specific details, operators and trades and crafts are going to fall under this umbrella. We also believe the K-65 material intake calculations are bounding for the other residue streams in Plant 6. That would be in the

Sperry cake and the -- the barium sulfate -- and also the airport cake. There's some fairly large doses per unit intake that we'll get into that we -- we can talk about.

MR. GRIFFON: If it's okay, I was going to -- I was going to suggest why don't we get to some of those specifics now. We've got some general issues on the table and discussion items, but maybe we can start on a --

DR. NETON: Sure.

MR. GRIFFON: -- on -- and you can point to your report -- step us through it a little bit. We've all -- we've all reviewed this, but it's been kind of in a quick fashion, so it may be useful for everyone to hear. This is just the ratios that you --

MR. ALLEN: (Off microphone) (Unintelligible)

MR. GRIFFON: Uh-huh.

MR. ALLEN: (Off microphone) (Unintelligible)

DR. NETON: You need a microphone. Well, in specifics of handling --

DR. WADE: Let's just do a check. Can people on the phone hear me?

UNIDENTIFIED: Now, yes.

DR. WADE: Okay. So I mean I think it's

important that each of us put the mike very close and speak directly into it. Okay? Jim.

DR. NETON: Yeah. Okay --

DR. WADE: Closer. I think you need to be closer.

DR. NETON: Sorry. If -- if you look at table one on page 5 of the document that we -- you know, that we -- oh, I'm sorry, I'm working off the original -- page 4, yeah -- it specifies the ratios, and Cindy can correct me if I'm wrong, but I believe those things came -- those doc-- values came out of the K-65 silo material. Is that right? Yeah.

MS. BLOOM: They're based on that.

DR. NETON: They're based on the silo material.

MS. BLOOM: They're a little bit higher than those ratios. It's just sort of eyeballing things.

DR. NETON: Right. So --

MS. BLOOM: (Off microphone) (Unintelligible) at the ratios.

DR. NETON: So this would be the ratio that one would use, whether you -- whether you went as a multiplier of the radium to the uranium in the urine or whether we applied the radon breath

analyses and came up with our own independent radium intake value. Then the progeny below radium 226 then would be apportioned relative to the radium value.

That's what we propose to use. That was an issue on the table at the last Board meeting. I think SC&A, and correctly, identified that we did not specify in the profile exactly what ratios of the progeny -- it was clearly our intent to put progeny in there, it just wasn't specified. When we talked about the 100 to one, we were not just going to put radium in there. We understood that there were other -- other progeny to include. This -- this outlines in more detail what our proposal is.

UNIDENTIFIED: (Off microphone) May I?

DR. NETON: Yeah.

DR. MAKHIJANI: This is Arjun. I'd like to ask you a question about table one. I looked at the original Silo One data, the averages, which may be the -- arguably the more -- most appropriate values. And because these numbers -- I don't know how they have been rounded or adjusted upward, but I think it will make a significant difference because in the original

data the -- the radium was 264 nanocuries per gram in Silo One, and thorium was 40, so the ratio is about 6.5, so thorium to rad-- thorium to radium is bigger, one to 6.5, than what you have here, one to eight.

And -- and similarly, the protactinium and actinium are bigger ratios to radium than what you have here, which is one to 80 and, as I have them, they're also like one to -- one to 65. And the reason I bring that up, although it appears to be a minor problem, is that -- at least by my back-of-the-envelope calculations, just reviewing your document -- the dose to the systemic organs will be dominated by thorium, protactinium and actinium. And so small differences in these ratios will make a pretty big difference, so you have to have some demonstrable way to show that the ratios are claimant-favorable in terms of maximizing the thorium, actinium and protactinium.

MS. BLOOM: There -- there was no intention that these numbers be taken as the final numbers. We were working really, really quickly to get something out that you could all look at --

DR. NETON: Right.

MS. BLOOM: -- and to try and just make the numbers simple. But I think that's a good comment, that -- that you want to look at exactly what is in that source term. We looked at other -- you know, this is the K-65 information. Barium sulfate that they -- they didn't always process Q-11, the African pitchblende ores, there. They processed a lot of other things. So these -- these relative to uranium are going to be inflated anyway. A lot of the other material that was processed were concentrates, which would not have had the radium in it, and probably would have less of the other progeny in it, as well. So --

DR. NETON: Right.

MS. BLOOM: -- this is just...

DR. NETON: Yeah.

MS. BLOOM: The details, certainly we'll take comments on those and -- and by the time we turn this out as a final product, it will hopefully be --

DR. NETON: I'd like to take a step backwards, though, and explore the -- the issue of using the Fernald data. I mean that -- that, to me,

was not a foregone conclusion. It was discussed in some detail, maybe a little detail at the Board meeting and -- and we indicated that -- I mean I think Arjun even supported the fact that we'd go down that path. Now that we've done that, I guess I'd just like to get the sense from the working group at least, does that seem to be a reasonable approach -- and in SC&A's opinion, as well -- that -- is this -- is this, you know, something that -- that this is reasonable?

MR. GRIFFON: (Off microphone) Arjun's got...

DR. MAKHIJANI: Yeah, this is Arjun. I think the Fernald K-65 data are a very good starting point. And then you've taken them in a -- one direction by doing radon breath data, but I think -- I think one of the really good things about this document that you sent us is the -- is the flow sheets. And it's clear that most of the radium goes away in the first step, so most of the radium winds up in -- in the K-65, and so the ratios of thorium to radium are lower in the K-65 than they are in the steps where most of the thorium was precipitated out -- or protactinium or actinium. So I -- I

think this problem that I was mentioning is actually going to be accentuated since you're using radon breath to determine radium and then applying the K-65 ratios to that. Whereas in other areas of the plant where you have the radium mostly gone, you would have bigger ratios of thorium, protactinium and actinium to radium. And there doesn't seem to be a good way to determine those ratios based on the K-65 silos. There may be other measurements, and I haven't -- you know, there -- I know there are some other ratios in here, but I haven't had time to actually figure out whether -- you know, how they've been done and whether they are appropriately claimant-favorable or what data they're based on and so on. But I think it'll make a big difference.

DR. MAURO: I'm sorry to interrupt -- this is John again. I do have a question, which is a simpler question which I wasn't quite sure of. As I understand it, the ra-- in order to determine the body burden of radium, sounds like the emphasis is going to be placed on the data that you have from the radon breath analysis. But at the same time, I look at this

table one and I see that you have this 400 to one ratio of uranium to radium -- or radium to uranium, and it seems to me that what we have here is two different strategies for coming up with what might be the radium intake --

DR. NETON: Right.

DR. MAURO: -- that a person experienced. And I'm not quite sure which one you've decided on using and under what circumstances, and which one might be more limited. Could you help me out a little bit with that?

DR. NETON: I think -- I think it depends on the individual case, but certainly if one takes -- well, in looking at the workers, we have come to the conclusion that very few workers inhaled pure residue material. So if one takes their uranium intake and multiplies it times 400 to get the radium, that will give you a much higher intake of radium than we believe to be the case. And that's when -- I think I even mentioned at the Board meeting that we would use the radium -- radon breath to do some bounding, sort of sanity checks on doing so. Because one has to remember that this was a wet process, for the most part, going through. And

even when the residues were created, they were wet -- within the plants. So you know, the potential for airborne is -- is somewhat minimal.

We believe that -- and so if one takes the uranium intake, multiplies it times whatever number -- 400 -- you will start ending up getting intakes that exceed the air concentration data that we're seeing in the plant. And if you look at Table 29 in the site profile, you'll see anywhere from ten to the 5th, ten to the 6th picocurie per year intakes. I think there's one or two incidences of ten to the 7th. If one comes up with an intake of uranium for a worker that is already ten to the 6th, now you multiply that times 400, you end up with a couple order of magnitude higher than what would be supported by the actual air monitoring data. That's doable, and that -- that is a calculation that can be done to certainly bound the dose.

DR. MAURO: That's very helpful. I did not understand that.

DR. NETON: But we believe that the better approach is to use the radon, as I indicated at

the Board meeting, to -- to use that to bound the intakes because we believe -- and almost any way you look at the radon breath data, it's going to be biased high. There are problems with radon breath. There was variability. The radon background in the air adds to it. The time of day when you take it, the fact that workers were not off work for a long period of time and could have been breathing radon gas that would be indicating radium body burdens is going to -- all it's going to work is creating a slightly larger body burden than you may have otherwise.

DR. MAURO: On -- on that matter --

DR. WADE: Denise, use the microphone, please.

MS. BROCK: Sorry, John. I just want to make sure I understand. If you're talking about the air, would you give the claimant the benefit of the doubt, would you count that all as uptake? Or...

DR. NETON: I'm not sure what you're asking. If -- if --

MS. BROCK: When they exhale -- if I understand this correctly, when they exhale, you're counting up that there's possibly that in the

air, as well. Correct? So are you --

DR. NETON: That would actually add to the --

MS. BROCK: So you will not subtract that from them. Correct? You will go ahead and count that all as uptake.

DR. NETON: Right, there's no way we would be able to subtract that.

MS. BROCK: Okay.

DR. NETON: So we would just assume that it was all -- all -- all related to radium --

MS. BROCK: Thanks.

DR. NETON: -- acquisition within the body. The other thing is when -- Cindy -- Cindy mentioned this earlier, when you take the uranium intake calculations and then use the radon breath, you end up not too far off from what the air data are telling us anyways. I mean you'll -- you'll end up in the same ball park and it -- given the uncertainties of the data, it's not -- it's not that -- it's not that we're suggesting that these intakes are an order of magnitude lower than what the air data suggests. It's that the approach that we've proposed provides a more consistent indication. When one looks at the totality of the radon

breath, the uranium intakes and the air data, using the radon breath in combination with the uranium data in urine, gives you in the same ball park as what the air data is telling us. And that gives us some comfort that that -- that seems to make some sense. Applying these 400 to one ratios tends to take you out of the realm of reasonableness.

MS. BLOOM: Well, and the other thing that I would say on the 400 to one --

DR. NETON: Speak into the...

MS. BLOOM: -- is that -- the other thing I would say on the 400 to one ratio is that if you're going to start with air data, you shouldn't be multiplying that times 400 --

DR. NETON: Right.

MS. BLOOM: -- and calling it all radium. You should be going the other way, and so that's actually going to bring numbers down, I think.

DR. NETON: Right, that would be my -- my proposal. We use the air data -- we would take the uranium data in urine and use that to estimate intake, and then assume that the entire air data were some fractionated values of the alpha in the -- in the radium stream.

But we -- we believe that -- that -- we believe that use the radium -- the radon breath data is -- is the more defensible scientific approach.

DR. MELIUS: Can we just go back one second to Arjun's original comment on the ratios 'cause I just want to make sure I understand your response. I think we sort of got off-track there. And you're saying that those -- you're going to adjust these now, and then -- that's all I've heard is you're going to -- there's some adjustment going to be made. This is just a --

MS. BLOOM: This is a --

DR. MELIUS: -- preliminary (unintelligible).

MS. BLOOM: Yeah, this is a -- this is a work in progress. I've collected a lot of different numbers on -- it sounds like -- I haven't heard anybody say that we should use the Silo One K-65 numbers, but if that's -- those are the numbers we're going to use, then I'll put lots of significant digits on there, and this was just to make it easy to say if I multiply by two I can get 800 rather than 1.578 -- something, so it's for my convenience.

DR. MAKHIJANI: Yeah, I'm not focused on the

specific numbers of the K-65. Generally -- you know, I think if -- there is a -- and I haven't looked at the radon breath raw data so I'm not commenting on the quality of it and questions about the minimum detectable limit and so on, but for the moment just accepting the radon breath data, certainly we've looked at the method. And for the record, we would agree that the radon breath method is well established for estimating radium body burden. And we had two different SC&A experts examine this question. They both agreed on this question, the question of the validity of the data, the detection limits and so on.

My question isn't about -- isn't about the -- the actual numbers of nanocuries per gram in the K-65 silos. My question is how are you going to come up with the thorium 230, protactinium 231 and actinium 227 numbers? And since those arise out of your radium measurement and you're applying a fixed ratio derived from the K-65 silos, you're saying I -- I know the radium burden in the body because I can measure it. Just consider one worker for whom you have bioassay data and radon breath

data, and you've got all good data. And then you're saying you're going to apply the ratios from the K-65 silos. Thorium is eight times less and actinium is 80 times less. And so my first point is it makes a big difference whether you say thorium is eight times less or 6.5 times less because it makes a big difference to the dose. So being precise about that number is very important -- about that ratio, not the actual value. So I wasn't taking issue with the specific --

MS. BLOOM: (Off microphone) No (unintelligible).

DR. MAKHIJANI: -- numbers, just the ratios. The second point, which I think is methodologically more complicated, is that once you leave the first step in the Plant 6 processing of the uranium, you wind up in places where the relative amount of radium is much lower and the relative amount of thorium, actinium and protactinium is much higher. So for -- for instance, in the residues coming out of the sodium carbonate bicarbonate process, in the AJ-4, AM-7, in all of those areas, I think there is a big problem in applying the K-65

ratios because there the relative amount of thorium is much bigger and it will make a tremendous difference in the dose because the dose conversion factors for thorium are so much bigger than radium.

Rad-- I did some back-of-the-envelope calculations, just applying the -- just taking 455 by -- just as a back-of-the-envelope thing -- to calculate percentages. And radium and uranium make almost no contribution to the total dose. The contri-- 95 -- if you omit lead and polonium and just take those four -- or even if you include them, lead and polonium make 10 percent -- uranium -- uranium and radium make less than a couple of percent, and the rest of it is all -- those three radionuclides. So my -- where I am, tentatively at least, from -- from a very tentative evaluation, is this whole method has to be geared to ensuring that the values you come up with ultimately for thorium, actinium and protactinium have to be the maximum plausible values, not the values for uranium and radium.

DR. NETON: I think we -- we totally agree with

that, and -- and I think -- we've stated in here that we believe that the -- applying the K-65 ratios -- because it's not that there's zero thorium or zero protactinium or zero all the other daughters in the K-65; there are -- and I think we've looked at the airport cake material. I think Cindy's looked at some of the thorium contents of the airport cake, which by far and away is the largest amount of material. I mean there's 20 -- 25-foot high 3-acre piles out there at the St. Louis Airport site, so this -- this is the biggest potential source of exposure. And if we look at that and we know that the thorium 230 is in the airport cake, which is the largest potential source of intake, and we -- we can demonstrate that applying the K-65 doses are bounding compared to -- admittedly, there's more thorium there, but I think, Arjun, in some cases you're maybe not totally correct. I think you'll -- you'll -- I was surprised to see when Joe discusses these things, polonium 210 is a very significant contributor to the internal doses to some of these people.

DR. MAKHIJANI: (Off microphone) I just

(unintelligible).

DR. NETON: Well, right -- I mean but you've got to be careful when you generalize across the board, but -- and when you use 50-year doses versus annual doses because thorium's got a short half-life, there's other -- there's other considerations. But I think it would be our intent to demonstrate that even under those circumstances the K-65 residue dose conversion factors will bound the doses to people working with airport case and possibly even Sperry cake. Those are the only other sources you've got out there is the barium sulfate cakes. Those are smaller residue streams by far compared to the airport cake and the K-65. So...

DR. MAKHIJANI: I don't think I -- I'm not sure that I got a response to the question I asked, which is -- and -- and I just want to be clear in -- in that I -- I don't think -- okay, let me make a statement and try to get a response, agreement, rebuttal, something. Is I don't think that the K-65 ratios for thorium to radium -- because we've gone away now from the ratios to uranium, which is the bioassay data,

and we're fixing everything on the ratios of thorium to the radon breath data. So now instead of bioassay data being the central anchor for dose reconstruction, you've got the radon breath data, which is available only for 20 percent of the workers, as being the central anchor for dose reconstruction because you -- you've constructed the amounts of thorium, actinium and protactinium out of the radon breath data and not from the bioassay data anymore. And -- at least as I read it. Therefore, those ratios are extremely critical. And as I read these flow sheets, the ratios in the areas where you've got these AJ-4s, Sperry cake, AM-7 of thorium and perhaps protactinium, actinium in different parts are going to be bigger than they are for the -- you should expect them to be bigger because most of the radium is gone in the first part of the process -- or almost all of it is gone.

So my question is, for those sets of workers where you know that their intake of thorium relative to radium is bigger -- is actually may be bigger than one to one -- how are you going to determine those ratios 'cause I don't think

the K-65 ratios are -- are reasonable or claimant-favorable? I'm just making that as a statement to --

MS. BLOOM: No --

DR. MAKHIJANI: -- get a response --

MS. BLOOM: -- and I --

DR. MAKHIJANI: -- and not a conclusion.

MS. BLOOM: -- and I think we agree with what you're saying. I was just looking at some numbers now. I do have uranium and thorium ratios in the AM-7, and certainly we could go back to the uranium data and apply those fractions to the uranium data. I think that would be a reasonable way to go. I need to look at it a little bit more.

Like one concern I have, I think the SEC question is can we bound it easily. The dose reconstruction question is then does the answer make sense or can we get a better answer. And I think we can use the ratios in the AM-7 to bound it. I think, based on what we were seeing from the uranium to radium ratios, I think that we can get a better number on the thorium to uranium ratios by considering that the fact that you've got a uranium background

in all these areas and so those ratios really aren't that high.

We've also taken it a little bit farther since we've written this up and looked at -- we had a small set of thorium bioassay data and we looked at that for the Plant 7E workers. They also had some uranium data, so we've sort of looked at that comparison, as well. And there's some arguments to be made there to -- to come up with those numbers. I don't think we've finalized that yet except to say that I think the SEC question is answered. We can come up with a big number. You know, we can come up with our --

MR. GRIFFON: Well, we -- we have no doubts about that, but I -- I think item (c) in one is where we're -- I mean that's one question we had in mind before was --

DR. NETON: Right.

MR. GRIFFON: -- are there going to be -- and this is what Arjun's getting at, are there going to be job-specific ratios or -- or area-specific ratios. And -- and it seems like -- I mean I -- I think the Silo One data is probably bounding in man-- in most circumstances. Now

if you have -- are there other areas where this -- this actinium, protactinium and thorium concentrates more and would there likely be workers that were dedicated to those areas, I don't know those answers, you know, if you --

DR. NETON: No, I understand that. But I think --

MR. GRIFFON: And also, you know, you -- you're -- when you have the Silo One waste, it -- it is -- we're all talking about this is a bounding sort of concentration and ratios that we're establishing from that, but -- but it is all the waste coming together, I guess, so you're -- it's sort of an average, you're blending it. Right. It might be a higher average.

DR. NETON: I think it's higher --

MR. GRIFFON: Right, right.

DR. NETON: -- K-65 material, which was not all the material that was processed. We're assuming that these workers were inhaling K-65 ratios the entire work time not, you know, when there were lower amounts of radium. We're not accounting for that at all.

DR. WADE: Denise had a comment or question.

MR. GRIFFON: Right, yeah, Denise.
MS. BROCK: My question -- I actually have two, and then maybe I'll ask them both and you can answer them separately. Number one, I was just curious, if the K-65 residue that's in Silo One at Fernald, does that ratio or chemical make-up, does that change after all of those years? I -- I'm not sure. I have no idea. That was a question I had.
And the other question I had is to Cindy and I -- I partially remember this. I was on the telephone call we had previously, and I'm not sure where this fits in at, but did I hear you correctly when you said it's 120th of the -- was it the dose or the -- it lowers their dose, is that -- do you know what I'm talking about?
MS. BLOOM: (Off microphone) Not yet.
MR. GRIFFON: Factor of 20 lower I think you --
MS. BROCK: Is that what it was?
MR. GRIFFON: -- said, based on the radium from the breath data. It might affect the overall doses by a factor of 20 --
MS. BROCK: That's it.
MR. GRIFFON: -- was the statement --
MS. BLOOM: Rather than --

MR. GRIFFON: -- (unintelligible) recall.
MS. BLOOM: -- directly using the K-65.
MR. GRIFFON: I think so, right.
MS. BLOOM: Right, right.
MR. GRIFFON: I think that was your statement.
MS. BROCK: So does that lower their dose?
MS. BLOOM: If -- if you look at using the K-65 ratios themselves versus the uraniu-- the radium -- the -- the radium intake to the uranium intake, and this was for an unmonitored worker who -- our sense right now is that an unmonitored worker is likely to be a less exposed worker, and I know that's, you know, over -- over -- you know, we're applying these numbers for the whole work period. I don't say that there's not unmonitored workers here and there. I think there are. I've worked in health physics long enough not to be that naive, but I think -- overall I think we're applying these numbers very generously, and it will -- if you use the radon breath data, the numbers will be lowered if -- if you start from the air data and multiply by 400 -- or the uranium data and multiply by 400, yes, that will be --

MS. BROCK: So it won't be as claimant friendly to do it that way.
MS. BLOOM: But it's not supportable when you look at the rest of the data.
MR. GRIFFON: I think that's what they're saying is this is now a better estimate --
MS. BROCK: This is better.
MR. GRIFFON: -- in their view, right --
MS. BROCK: Okay.
MR. GRIFFON: -- and the other one was -- was reaching over reali--
DR. NETON: (Off microphone) Over (unintelligible) bounding --
MR. GRIFFON: -- right, it was --
DR. NETON: It was borderline --
MR. GRIFFON: At least that's the position --
DR. NETON: -- reasonable.
MR. GRIFFON: -- that's the position they're taking on it, yeah.
MS. BROCK: And does the silo -- does the K-65 -- does that make-up change at all?
MR. GRIFFON: (Off microphone) (Unintelligible) second question.
DR. NETON: Well, that second question is -- that's what -- we need to talk about that, but

I think, you know, there's -- there's evidence that this material was stored in drums over time. It was placed in drums and it was put inside a concrete silo. It was not subject, at least totally, to leeching of -- of rainfall and that sort of thing, so I think we have some confidence that these ratios are not -- not significantly different than the original ratios that were, you know, present at the time the material was made.

The concentrations will certainly be different. They've been diluted with different types of material, bentonite clay and that sort of thing, but -- but the ratios themselves, I don't believe there's any good reason to believe they're substantially different.

MR. GUIDO: Yeah, I had a comment. From a dose reconstruction perspective, one thing to keep in mind -- reality in doing this and I really understand what you're -- where you're coming from when you say how do you -- how do you know that Worker A, you know, where they were in the plant in all time, and -- and looking at a lot of other site cases and specifically a lot of Mallinckrodt cases and a lot of data, I agree,

it's very difficult to place a worker.
A lot -- there's a lot of data within the files which is even inconsistent with each other, like you -- you know, where -- you don't whether the person was bouncing back and forth between areas or whether they changed assignments. So in the reality of doing the dose reconstruction, the way it has to be applied is you have to come up with a bounding scenario and apply it. And that ends up being claimant-favorable for a couple of different reasons.
One, because you're picking a bounding scenario to give them, and another because you don't generally turn off the intakes when they really maybe should have. And in an example we'll maybe get to later if we look at one of the cases I did, you know, you might have an individual who has radon breath data for the first two or three years of their career, and then for the last two of three year-- you know, that -- that data goes away, they never get any more monitoring for radon breath, but they might pick up like thorium monitoring.
Well, some sense would say well, that worker

probably changed locations. But in doing the dose reconstruction, in the methods we use to be claimant-favorable, what we would do is they would get the intake from that radon stream for the entire work period, and then it'd also pick up the other intake from the thorium and you wouldn't turn off the radium 'cause you really don't have data to say that it really ended. So you know, I know it's important to understand where people worked and what the ratios are in different areas, but -- to build the ratio set to understand what's bounding. But when you actually do the dose reconstruction, you -- that data is not as important. You know what I mean? It's -- it's more important to make sure you have the bounding set, because we'll never know where all these folks worked at all times. All we'll know is the possible datasets and then we can assure that we're being bounding, we're being claimant-favorable.

MR. GRIFFON: Yeah, and -- and we -- and we -- and that's -- and we can see why you would want to go with radon breath data for that reason, you know --

DR. NETON: (Off microphone) Cindy (unintelligible).

MR. GRIFFON: -- instead of air sampling area data or -- yeah.

DR. NETON: Cindy, you said you have the data for the airport cake for thorium 230. Do you have that handy? I'm just curious about the disparity between the two.

MS. BLOOM: I do have some -- I do have some numbers. I was just looking up my calculations and my numbers in my comparison spreadsheet are in the wrong rows right now so I need to adjust those, but I can give you those this afternoon.

DR. NETON: You don't have a number for the concentration of thorium 230 in the airport cake handy right now then?

MS. BLOOM: I do in odd units.

DR. NETON: Okay. Well, we -- we --

MR. GRIFFON: I guess -- I guess --

DR. NETON: -- can probably talk about that later.

MR. GRIFFON: Yeah.

MS. BLOOM: (Unintelligible) per meter or parts per million, which would you like?

DR. NETON: I'd like picocuries per gram, but -

-

MS. BLOOM: Yeah, that's what I thought. Then give me a minute.

DR. NETON: That's what I -- I think -- I think we can -- we can --

MR. GRIFFON: Yeah, I guess -- I guess --

DR. NETON: -- talk about that --

MR. GRIFFON: -- I guess there's general agreement here that -- that applying the fractions if -- if -- if we can get to that point where we're happy with the bounding --

DR. NETON: Right, and then we can get to the (unintelligible) --

MR. GRIFFON: -- that -- that -- that approach is reasonable, I think.

DR. NETON: Right. See, now I --

MR. GRIFFON: But the -- the -- I said the general position is that if we can establish these fractions and agree that they're maximizing or bounding --

DR. NETON: Right.

MR. GRIFFON: -- then the approach to use them is -- is reasonable, you know.

DR. MAKHIJANI: Yeah, I'd just like to be clear what "these fractions" mean, because I think in

most situations we're going to find that -- it's just my hunch from back-of-the-envelope calculations that the thorium, actinium and protactinium are going to be important. And my concern simply is that those are the radionuclides for which there is the least information. There are no direct measurements, there are no air concentration data, there are no bioassay data and there are no radon breath equivalent data, so they're all derivative numbers. And how -- I think --

MR. GRIFFON: Even in -- even in the --

DR. MAKHIJANI: -- there has to be some assessment on how good those values are and how confident we are that they'll be maximum plausible because --

MR. GRIFFON: Right.

DR. MAKHIJANI: -- I -- I don't -- I haven't seen something that allows me to say that we know that to be confident as yet.

DR. MAURO: John Mauro. I'd like to just add one point. Joe Guido's point that you just made was exactly the question I asked much earlier about the creation of these boxes and the boundaries for real people. And the fact

that your plan is to give the benefit of the doubt where the person was and to carry over the -- let's say the continuation of exposure on that basis resolves that concern that I raised much earlier today. Thank you.

MR. GRIFFON: All right, I think we -- are we on to 1(b)? Moving right along.

DR. NETON: I think -- yeah, I think we're -- we can -- we can resolve this issue with the amount of thorium 230. I --

MR. GRIFFON: Oh, yeah.

DR. NETON: -- I thought we'd looked -- we have looked at the airport cake and we know the amount of protactinium that was in the -- in the Sperry cake that we shipped to Fernald -- or shipped to Mound, so I think between those two we're able to get some consensus maybe as to what the bracketing values should be for the thorium 230 and --

MR. GRIFFON: Okay.

DR. NETON: -- I think that's good. Okay, 1(b) --

MR. GRIFFON: Actually I think 1(c), yeah.

DR. NETON: -- 1(c) --

MR. GRIFFON: 1(c).

DR. NETON: I think we've talked about that a little bit. We feel that it's going to be very difficult, as Joe just indicated, to apportion these to individuals every single step of the way. I mean it's -- it's just a practical limitation on -- on doing so and -- in fact we don't have that for everybody, so our -- our approach is that if we could come up with this bounding calculation, these -- these ratios, and if we could use the radon breath data, that we would assume that most categories of workers that at least worked in Plant 6 -- so we're talking about operators, building trades, all those types of categories -- we would assume that they were exposed to this bounding value of -- of the residue material, the raffinate material (unintelligible).

MR. GRIFFON: When you bounding value of raf-- can you point me to...

DR. NETON: Okay, well, let me -- let me --

MR. GRIFFON: Okay.

DR. NETON: Okay. The approach would be you take the urine data, if it's available, and come up with the uranium intake. Now that's -- that's a given. Now you've -- you determine

what the uranium intake is. Now if you have radon breath, you do the radium intake and you've got radium intake, and then we can apply whatever ratios we decide is appropriate.

MR. GRIFFON: And in the absence of radon breath, you use --

DR. NETON: In the absence of radon breath we would propose to use the 95th percentile of the radon breath intakes that were calculated from the 2,500 samples. And likewise, in the absence of any uranium bioassay we would use the 95th percentile of the uranium intakes for that population of workers. So you've got a situation -- now that would be for workers who were potentially exposed working with raffinate just like anybody else, a chemical operator, building trades or someone of that nature. If you have a worker who did not work in Plant 6 but could have frequented it doing certain jobs, we propose that we would use the distribution, the -- the distribution of values for radon breath and uranium bioassay and apply that to those --

MR. GRIFFON: The full distribution, you're saying --

DR. NETON: The full distribution rather than picking the 95th percentile. So I think if we can come up with this -- these fractions, these activity fractions, I think we've got an approach here that is workable for --

MR. GRIFFON: And do --

DR. NETON: -- almost anyone in Plant 6, and in Plant Y, for that matter. If someone -- if we can demonstrate someone only worked in Plant 4, which may or may not be possible, we would not apply that ratio.

MR. GRIFFON: And -- and just to be clear, the use of the air sampling data now would be to -- as a reality check, as a --

DR. NETON: Yes, that's exactly right. It would be -- it would be used to make sure that we're in the right ball park here. And I think in our preliminary calculations that's the case.

MR. GRIFFON: And that your overall -- like you were saying earlier, that your overall alpha intake doesn't exceed the plausible with the highest air samples in --

DR. NETON: And actually I think it would be --

MR. GRIFFON: -- in the plant or...

DR. NETON: -- it could exceed it. We're not saying that the air sample data are the ultimate --

MR. GRIFFON: Right.

DR. NETON: -- cap, but are they in the right ball park.

MR. GRIFFON: In the right ball park, okay.

DR. NETON: And if you're three or four orders of magnitude higher with your intakes, you might want to wonder. But then as we -- as has been pointed out in the past, the air samples are not perfect, either. They might not have been job (unintelligible) --

MR. GRIFFON: So there's no situation where you see those being used for dose reconstruction.

DR. NETON: At this point I think we would prefer to stick with the bioassay monitoring data as our -- our approach and use the air sample data as -- as --

MR. GRIFFON: Reality (unintelligible).

DR. NETON: -- reality checks on what we're doing.

MS. BLOOM: It also might give you an indicator of what was happening over time, you know, and -- and how to help fit data and things like

that.

DR. NETON: It's amazing how these all kind of come --

MS. BLOOM: On a case by case basis, it could be...

DR. NETON: In the first few dose reconstructions Joe's done I was very pleased to see that the -- the estimates -- and we didn't presume this, you know -- came out fairly close to what the air data -- the air data are showing. Of course within an order of magnitude -- ten to the 5th, ten to the 6th picocuries per year -- but very similar to what I showed at the last Board meeting where I had these 95th percentile bounds on the intakes and the air data kind of -- kind of fit that in there.

Okay. So I think --

MR. GRIFFON: Any -- any questions on that one anybody have?

(No responses)

I think we can go to 1(d), yeah.

DR. NETON: And I think 1(d) we've also actually covered that. I mean the approach for when -- combination of urine sampling and

breath data, we would use urine and breath, as available, to do intakes. We would use the -- what we call coworker data, which is really the worker distribution data that we have for urine and breath, and pick the 95th percentile for exposed workers and the full distribution for what we believe to be lesser exposed workers.

MR. GRIFFON: I think the second part of (d) -- I mean we didn't really discuss too much --

DR. NETON: Okay, reliability of radon breath data, we could talk about that somewhat. I -- I'm encouraged that SC&A does agree that -- that radon breath is an appropriate technique. It was in fact the -- the intake estimates that were used to establish the body burdens for the radium dial painters, which everyone knows is a fairly famous historical exposure cohort from the early 1900s. The radon breath data we've looked at. We actually have very similar data to what we had for the urine analysis. In fact we have the HASL analytical data sheets. There's four -- I would not -- don't quote me on this number, but I think there's about 487 individual pages of radon breath measurements that were reported by HASL to Mallinckrodt.

These data sheets contain -- they're not full, but again, they're like 14-line data sheets, so they're -- somewhat less than half of each of them are full, so there's a large number of radon breath measurements that were taken.

We wanted to make sure that the CER database was actually reflective of what as in there. We looked at a few workers. We didn't do as extensive review as we did with the urine, but we took one worker and were able to track his radon breath data back to his original HASL data sheets. They matched. I think there was one date that was transposed -- you know, the date was read wrong; it was 4 instead of a 9, but in general those appear to be faithfully reproduced in the CER database.

These values are listed as percent of tolerance. The percent of tolerance was one picocurie per liter radon in breath at that time. That was I think construed to be equal to what would be a body burden of radium during that time frame.

The detection limit value is pretty clear from the HASL reports that they reported nothing -- well, almost exclusively nothing less than .1

picocurie per liter. There are some samples that are listed as .006 picocurie per liter less than values. We're not quite sure what to make of that. It's a very small fraction -- I can't give you the number, but very small number of them. If you read the original reports, HASL -- .1 picocuries per liter is -- is a fairly well-established detection limit. In fact, this technique is still -- I have a 1992 version of the HASL analytical procedures manual. This exact same technique is still in there.

John has a question.

DR. MAURO: Yes, I -- I looked at the protocol and some of the literature behind it. In fact there was the -- I think it was the Russian literature -- started with an S, long name --

DR. NETON: Uh-huh, (unintelligible), yeah, I won't pronounce it, either, but --

DR. MAURO: You know the one.

DR. NETON: -- I know what it is.

DR. MAURO: Now I noticed in his analysis he used -- the person would breath oxy-- breath oxygen beforehand --

DR. NETON: Right.

DR. MAURO: -- and there was a very sophisticated protocol to make sure that you had control over background --

DR. NETON: Correct.

DR. MAURO: -- so that you could get a realistic measurement. Now in our situation here, that wasn't done, as I understand it.

DR. NETON: In the early time frames that was not done.

MS. BLOOM: Later on they did --

DR. MAURO: Later on.

DR. NETON: After '51, '52 time frame they adopted the HASL procedure --

DR. MAURO: Okay.

DR. NETON: -- with John Harley's 1951 article in the *Archives of Industrial Hygiene* published -- I've got a copy of it here -- it goes through that -- that procedure.

DR. MAURO: Then my question goes to the earlier years. In that scenario where you're dealing with an individual where you're using the radon breath data before they were using the oxygen approach, and therefore you could theoretically have a background level that could be substantial. It doesn't take very --

you know, in this room is probably about one picocurie per liter right now. Now, when you do that, if in fact you've used the radon breath data without subtracting background in the early years, you may very well come up with some very aberrant results. Under those circumstances, what's your fall-back position in terms of coming to grips with what the body burden of radium is when you really suspect that because -- because of the background complication?

DR. NETON: We -- we really have no way of correcting for that and we would assume that this was equal to the radium body burden. If -- if you look at it over time, it did go down. But of course there's a reason for that. In the -- in the '40 -- late '48, 1949 time frame this is when they had the campaign to reprocess the -- the K-65 material from SLAPS, so they ran through all of the -- or most of the radium-bearing K-65 material through the entire digester process. So there's a reason that those body burdens could be higher, but I -- I don't think that we would correct those. We would use them at face values.

There are other issues besides just the radon breath, and we can talk about that a little bit. The background in air -- there are also these people that worked in the plants. As we'll see later, there are very large concentrations of radon in the plant, well beyond -- all above a picocurie per liter. I myself have measured the half-life of radon gas in the body and it's about 24 hours. They did adopt a protocol where the workers came in on Monday morning after being away from the plant for 48 hours, recognizing they wanted to ventilate the natural deposition of radon in their bodies. Unfortunately though, they took some of these measurements early on in -- in rooms that had air that had higher than what you'd expect, and so some of that is contributing to the background.

But as I mentioned earlier, most of these uncertainties do -- as you mentioned, do bias the values in a positive direction, not a negative direction.

MR. GRIFFON: (Off microphone) Larry's got a comment.

(Whereupon, the microphone available to Mr.

Elliott was not functioning and his remarks were not captured by the reporter.)

DR. NETON: Right, yes. I'm not -- yeah -- well, we've never done that in any dose reconstruction so we take that at face value. But the other issue is there is a -- radon breath tends to be higher after eating a meal, what they call the postprandial effect, and it can be a factor of two higher. So if someone had breakfast and came in, it could be -- all of these things, again, add to the elevation of the data and not -- not negative biases, so -- but we believe it's a fairly reasonable bound.

MR. GRIFFON: Go ahead, Arjun.

DR. MAKHIJANI: Yeah. I'm sorry to sound like a broken record a little bit about this, but I do feel it's important. And I'm just trying to understand how these coworker radon breath data are really going to be used. We -- we've got radon data for 20 percent of the workers -- about. So for most of the production workers you're going to wind up using coworker data. Right?

DR. NETON: (Off microphone) (Unintelligible)

DR. MAKHIJANI: Yeah, I'm not -- I'm not saying

that the approach that you outlined is not claimant-favorable, I'm just trying to understand the approach since this is the last full conversation we'll have about this. Then -- then you apply these ratios -- use the coworker data from radon breath and apply these ratios. Now if the assumption is that the radon breath was applied to people who were vulnerable to radium exposure, which would mean those who were working with the ore, pitchblende; those who were working with K-65 material and barium sulfate residues. I mean those are the ones who I identify as the ones most vulnerable to radium exposure. Then it seems -- it seems to me that actually applying the co-- the coworker approach seems to be questionable for workers who were working with other residue because these ratios are not going to apply because you don't have -- if you don't have radon breath data for most of the workers, many of those workers are going to be in areas where you're handling these AM-7s, AJ-4s and these various other residues. You don't have radium measurements for them and we have sort of an idea what the ratios were, but

you're going to apply -- I'm (off microphone) (unintelligible) difficulties how these numbers are going to be validated (unintelligible) those numbers.

DR. NETON: Right. I understand what you're saying, Arjun. I think -- I think the way to look at this is if you have a radon -- a K-65 material intake and you come up with some dose per unit intake of that material. Okay? Let's just make a number. Say it's 300 millirem per milligram intake. I don't know what it is, but let's just say it's that, and it's based on these K-65 ratios. And then we can do some other calculation on these other residues and demonstrate that this intake calculation, however we -- we contrive this ratio -- I mean construct this ratios are higher than the unit intake per milligram of the other materials, then it's -- it seems to me that you would -- you've given these people an adequate intake. You know, you would have to assume that they would be inhaling -- you're assuming that they're inhaling this full-time, on a chronic basis, and if the dose per unit intake that we construct is bounding, even for these other

residues, I think that we've adequately given these people a representative dose. But then it gets down to how much material can you inhale. Does that help?

MR. GUIDO: I have a comment, but if you're satisfied I won't say anything.

DR. MAKHIJANI: Well, I -- I'm -- I'm puzzled, because I -- you know, actually we -- maybe this will be answered when you put your dose reconstructions on the table and I don't want to hold this up, but I -- I -- I am -- I remain puzzled as to how this (unintelligible) --

MR. GUIDO: So I'll comment. One thing we have to look at, and this doesn't really answer the question, but in looking at this approach the one thing you have to look at is if you start with a higher radium number intake and you use lower ratios, you might get more dose than if you -- in fact, in other words, we're -- we're going to assume that everyone was exposed to the stream that had -- that had much more radium in it. Well, the ratios -- the radium to thorium ratios might be a little lower for that stream, but the net effect as far as actinium, protactinium and thorium values might

end up being more bounding. And proof of this is going to be in the calculations, and we all realize this. But I think conceptually it's very possible, and we believe it to be true, that you can start with higher radium/lower ratios as opposed to lower radium with high ratios and your answer might still be in the same --

DR. NETON: (Off microphone) Come out the same place.

MR. GUIDO: -- so that -- that's what -- that's what we have to prove, I -- I guess.

DR. MAKHIJANI: Now -- now I think you've actually clarified something and made my question bigger, because -- because this -- because the difference in the dose conversion factors is so large, I think -- I think unless you can actually validate these numbers in some way, this qualitative idea that you can have a higher radium and lower ratios -- because at least by my back-of-the-envelope, which I'm not going to stand by these numbers. My back-of-the-envelope numbers show that that -- those -- the result is extremely sensitive to those ratios and not to the radium concentration.

You can take -- you can throw away the radium dose if you get the ratios right -- as an extreme statement. Admittedly extreme statement in the example that I did. The -- the -- and so if you have streams where the ratio of thorium to radium is two to one instead of one to eight or one to six, I think -- I think that this -- what you've said will -- will be very far from being claimant favorable. And you have to be able to demonstrate that you know these ratios, not just of thorium to uranium then. You have -- if you're going to use -- the thing that concerns me -- let me step back.

The thing that concerns me is you have bioassay data for most of the workers. I think we settled the bioassay data quality and so on issues, whether they were fabricated, to a large extent last time. They're not fabricated. They're a set of data that -- that -- that would give you an indication of uranium. You have them for most workers. Now we've moving away from that for the most important radionuclide. We have radon breath data, 20 percent of the workers, and that is

going to become the source of the values of radionuclides for the most important components of the dose, not the bioassay data which is a more complete set of data that you have for individuals. And I -- I -- I'm -- I remain to be convinced that this is -- this is a sound approach.

DR. NETON: Well, I guess we just need to show you the numbers. I mean that's --

MR. GRIFFON: Denise --

DR. NETON: -- (unintelligible) --

MR. GRIFFON: Denise has a comment.

MS. BROCK: I'm confused myself with some of this and I'd like to ask a question. I have a -- a document in front of me, it's very hard to read, and I don't know if this has anything to do with that, but I'm just going to read part of it and then maybe you can explain to me if it has anything to do with what Arjun or what you all are talking about.

It states (reading) It is apparent from these data that a considerable group of employees from Plant 6 are exposed to hazardous concentrations of dust. In Plant number 6 18 employees are exposed to between 375 and 660

times the preferred level.
And down further it -- this is so hard to read -- (reading) Employees exposed to 660 times the preferred daily alpha level inhale in 19 days the amount of alpha dust which would ordinarily be inhaled in the full working span of 35 years.
So my thought as to coworker data -- and this -- I may be way out in left field with this, but if hypothetically you're one of these workers and there isn't maybe breath radon or something on you and you use a coworker, wouldn't this person be a lot more exposed than just the typical person? And are they not going to get a full amount of -- of what they -- they should be in their dose? Or is this way off in another...
DR. NETON: Well, I think that speaks to us using the 95th percentile of the distribution and assuming that they were in the most heavily exposed population. That's what we would do.
MR. GRIFFON: Okay. I was -- I'm still on 1(d) --
DR. NETON: Okay.
MR. GRIFFON: -- and I've got -- I've got about

-- I've got a bunch of questions on that. I wondered if we wanted to break for lunch at some point or -- have I got one vote for lunch? Why don't -- if it's okay with everybody, why don't we break for lunch now and come back --

DR. WADE: I'd like to say one thing before lunch if I might. I mean early on Denise asked a number of questions that had more of a policy sense as to where does the SEC process sit relative to the site profile process. Those questions have not been lost on us, Denise. I think we're here today to talk about the -- the technical issues surrounding the site profile review. How that relates to the SEC process is something that certainly the Board will need to discuss more completely, so your questions have been heard.

MR. GRIFFON: All right. I guess we'll reconvene at 1:00.

(Whereupon, a recess was taken.)

DR. WADE: We've spoken during lunch to some of the members who are trying to participate by telephone and they say that you all need to shout, as I am shouting now, and be close to the microphone. And again, we value their

participation and to maximize it, we need to do this.

I would also ask those on the phone, if anyone starts to speak that gives you trouble, speak up and we'll reprimand the person forthwith and we'll have them speak louder.

We will be talking about today some of the example dose calculations, and those are here in hard copy. Mike Gibson, I don't know if you would like us to try and FAX that material to you -- are you on, Mike?

(No responses)

Is anybody on?

(No responses)

Well, my little speech didn't work. LaShawn, could we...

MR. GRIFFON: Speak louder.

DR. WADE: No, I don't think there's anybody on.

MR. GRIFFON: (Off microphone) I think we've got --

UNIDENTIFIED: We've exhausted (unintelligible).

DR. WADE: Not all of them. I can think of a couple who would -- who will be here.

DR. MELIUS: We have a few that will outlast all of us.

DR. WADE: No doubt about that.

MR. GRIFFON: (Off microphone) (Unintelligible) minutes (unintelligible)?

DR. WADE: No, I think we should -- we'll wait three and then we'll start.

MR. GRIFFON: Yeah.

DR. WADE: We don't -- now the clock is ticking on us. No, we're here till 5:30. We can be here longer.

(Pause)

DR. MAKHIJANI: Dr. Wade, are we going to go much beyond because I need to change my reservation.

DR. WADE: I don't think so. We can -- is there anyone on the phone who's willing to speak up?

MR. GIBSON: This is Mike Gibson.

DR. WADE: Mike, would you like us to try and FAX you the materials that will be the representative dose reconstructions that will be discussed later this afternoon? Is that possible?

MR. GIBSON: The printer I'm using right now

doesn't have a FAX machine on it.

DR. WADE: Okay. With apologies, those materials have just appeared today. We'll try and be clear in our discussions of them. Again, we've talked about here the need for people to speak as loud and as aggressively as I am, but if anyone starts to speak and those of you on the phone are having trouble, please shout out so we can make real time adjustments. My only other question is are there any Board members other than Mike on the call right now?

(No responses)

Any Board members other than Mike Gibson?

(No responses)

Okay.

MR. GRIFFON: I think Jim wanted to say something, then we'll get back to our agenda.

DR. MELIUS: Something that came up this morning I want to just make sure we're -- we're clear on in terms of our next meeting, and I think Cindy and Jim Neton were referring to sort of the ongoing work and further calculations and further changes, and I think that's all fine. But I think it's very important for the Board that -- that there be

good communication between NIOSH and SC&A beyond this meeting so that we don't get into our next meeting in St. Louis and have a -- something presented that no one's heard of -- I mean from both -- either side, either a criticism that's -- that's new or a new set of calculations or a new approach, because I think that's going to put us all in a very difficult -- or could put us all in a difficult situation. So you know, to the extent that you can exchange your, you know, information, critiques and so forth, I think that's good. I think we've got the process set up, but I just don't, you know, think -- you can certainly go beyond some of the dates involved if that will help to give a more finalized, you know, presentation at our next meeting in St. Louis.

DR. WADE: Good, and we'll let common sense prevail in terms of involving the working group. I think if it's possible, if we know there's going to be a call, we can let the working group members know and they could join. If that's not possible, I think we'll understand the intent of what Jim's saying. John, are you comfortable with that?

DR. MAURO: Yes, any developments whereby we'd like to discuss certain ambiguities in some of the issues we're talking about today, or the degree to which these -- we leave on the table, as we have so far, certain questions when we -- we're -- 'cause our plan is to prepare a report to the Board on our understanding and our position regarding each of the issues that we're discussing today so that you would have something well before the meeting. And in order to get to that point, what we will probably need to do is to discuss these matters with Jim. At that time we will get in touch with you, Lew, I presume, to let you know that we'd like to open up a conference call.

DR. WADE: Fine, thank you.

DR. MELIUS: But that -- can I just add, I think -- you'll prepare your report, but you also prepare your presentations. And you know, we get them at the meeting, you know. You prepare them the night before or whenever, and to the extent that those change what's in the report -- and that may be very appropriate that there's new information or -- change. I don't mind as much the Board being surprised by it,

but I would be concerned that -- if SC&A presents something and NIOSH is surprised by it or hadn't heard it before, and vice versa, so that -- that -- you know, you both have had a chance to think about it. And I frankly -- you know, the few days before the meeting, I don't want you wasting your time trying to set up a call. I'd much rather have there be, you know, communication. I mean you both should be close, but there may be some new wrinkle or something that would help to vet or at least have discussed so that people are prepared to, you know, respond to it at the meeting, to the extent possible.

DR. WADE: With permission -- all right, go ahead.

DR. MAKHIJANI: Yeah, as -- as -- Dr. Melius or somebody is going to be taking a first crack at the SC&A report anyway and drafting it, I -- I -- I -- there are a lot of outstanding issues already, and I actually asked John, are we -- are we going to see some revised thing from NIOSH in the next couple of days so that we can look at the resolution of them? Are we to submit -- I'm not clear on this, I think it's a

little vague, if you don't want surprises, 'cause there are big issues on the table. Are -- are we to send a draft on which then we will have a conference call? I -- I'm not sure exactly how you intend to prevent these surprises.

UNIDENTIFIED: (Off microphone) (Unintelligible) rest of the day and then (unintelligible).

DR. NETON: I think that -- that's acceptable.

MR. GRIFFON: (Off microphone) (Unintelligible) too, yeah.

DR. NETON: By the -- by the original schedule, SC&A's review to the Board is, right now, due August 16th. We're still 12 good days away from there, and you've had a very good peek at our position. Now I do admit that we're going to have to come to grips with some of these issues, but I would prefer to do that, as Dr. Melius suggested, with some open dialogue between us because this process of us developing a position and then getting a counterpoint formally, it just really takes much more time and effort than it would if we could discuss among ourselves. And I would

hope that we could do that without having to have formal *Federal Register* type noticed meetings because it just gets difficult.

DR. WADE: Well, if -- Mark, if it's agreeable with you and the other members of the working group, if -- if that's the sense of this working group, then -- then let John Mauro, Jim Neton and I sort of work through these issues as they come up and we'll do the right and proper thing within the spirit of what's been discussed here. And Denise, I'll certainly be keeping you informed.

MR. GRIFFON: Yeah, I think that's agreeable to all of us. I mean I -- like Jim said, we just want -- we want no surprises by the meeting, so that would be good.

All right, I think we'll go back to the regular agenda here. Item 1(d), we were discussing the second part of that, the reliability of the breath radon data, yeah. And I don't know, did -- I had a few questions on this that I just have looked at some of the data and a couple of things came up in my mind. One thing, looking at the hard copy data versus the CER database, I noticed that on my rough tally of this data

about 25 to 30 percent of the data in those two years said either lost or not analyzed. And I'm not sure what that -- what that mean-- you know, I don't know if you have a sense of what that meant from the HASL lab standpoint, if -- if they -- well, and -- and -- and second part of that is how would you handle -- if you had raw data with someone's name and all you had from them was something that said lost or not analyzed, how do you -- you just use coworker data, I guess, or --

DR. NETON: Right, that -- that would be our approach. And I'm surprised it's 25 to 30 percent is --

MR. GRIFFON: So was I, that's why I tallied up, yeah.

DR. NETON: I really don't know, you know, what happened to invalidate those samples or not pick them to be analyzed, but we would -- we would use the data that we have and -- and develop the coworker distributions then, you know, follow through that way. Cindy might --

MS. BLOOM: On some of those "not analyzed" samples there is indication in the records that the laboratory was unable to process so many

samples, and so some that may not have been processed may have been excess samples. Also just a general note on a "lost" sample, that tends to indicate that something happened during processing where the sample was invalidated somehow. It was either the chemistry didn't go quite right or something like that. It doesn't mean that all these samples were physically not found, but that the --

DR. NETON: Yeah.

MS. BLOOM: -- analysis didn't work the way they had hoped it would.

MR. GRIFFON: That's a general observa-- I mean you don't know preci-- for this dataset necessarily that --

DR. NETON: No.

MR. GRIFFON: -- "lost" meant that or...

MS. BLOOM: No, but I -- I have looked at a lot of bioassay analyses and -- and it's pretty typical. "Not sent" or "didn't arrive" or "blank" might indicate that a sample was somewhere else, but -- and it's definitely -- it's -- it's a subjective word.

MR. GRIFFON: I guess what struck me with this

was the high percentage. If it was, you know --

DR. NETON: Yeah.

MR. GRIFFON: -- a few percent, or ten percent even, I -- but it was 25 to 30 percent for these years and I thought that was rather high, especially when you're dealing with a fairly small dataset already -- well, maybe not that small, but anyway...

There's a -- also wanted to point out that -- I don't think there's any data in 1956 or '57, is there, for the radon breath? Any or very limited, I don't -- I don't know if that's... Am I right about that?

MS. BLOOM: I think there were four samples in '57. The program had pretty much -- had run down, the reprocessing of the radium was over. Towards '55 it had wound way down prior to that, but I think that probably -- my sense is that they weren't so curious about that anymore. I can't guarantee that there's not more data out there, but that was my sense, that -- that they just stopped measuring for radium, that they weren't processing that -- doing the reprocessing of the --

MR. GRIFFON: Okay.
MS. BLOOM: -- the radium anymore.
MR. GRIFFON: So that's consistent with the process history is what you're saying, that that --
MS. BLOOM: Yeah, they weren't doing the pitchblendes anymore, they were getting in concentrates instead.
MR. GRIFFON: Right. And -- oh, Arjun, go ahead.
DR. MAKHIJANI: Yeah. If we know they were doing concentrates at -- at -- I think that would be fine because then you don't have radium. But if they were doing other ores, you still have the disproportion of the radium at the filter stages 'cause that's not dependent on the grade of the ore, simply the uranium goes away. And so is it well established that they were doing only concentrates in '56/'57 or...
MS. BLOOM: I didn't look at that question specifically. That was just my sense as I looked at the different data and that things did wind down there, and that they had stopped at some point processing the pitchblende, even

though -- and that they were doing some concentrates later on. Also with the domestic ores you would have -- even though the ratios would be the same, the actual intakes would be lower because your concentrations would be lower, so -- and I just think they weren't measuring it. I don't -- and we're not saying we're not going to account for exposures. I think we're just going to -- as Joe said before -- take that line and draw it straight across 'cause we don't know how to fill it in without data.

DR. MAKHIJANI: Which line?

MS. BLOOM: The radon breath analyses results.

DR. MAKHIJANI: Oh, okay.

MR. GRIFFON: You're going to -- you mean -- draw it straight across, you mean extend it out to what years, to -- through '57 or -- yeah.

DR. NETON: Right, and -- and the numbers go down. I have some graphs here that were not distributed. These are just -- what I'm showing here on the screen --

MR. GRIFFON: Oh, okay.

DR. NETON: We did look at the distribution of radon breath analyses by year, and these are

NIOSH evaluations. They may be slightly different in the decimal place or two because we did these independently of ORAU team, but in general what we're showing here is distributions through '49, '50, '51, '52, '53 and '55 that are fairly -- you know, straight line distributions again, no real evidence of truncation of data, that sort of thing. And this last graph here is a breath radon trend, which shows -- it's a log scale, but the concentration of radon in breath went -- the median value went from about .3 in 1949 down to somewhere close to .1 in 1955 -- I'm sorry? Oh, yeah, .2, I'm sorry. Thank you, Arjun. And you -- you run into a practical issue here. The radon breath analyses, as we discussed earlier, have a detection limit of .1 picocuries per liter, so you have a missed dose issue here anyways. I mean we will assign -- you know, if -- if there were no positives in a given year, the smallest intake you could infer would be .1 picocuries per liter, which would be one-tenth of the body burden and that would certainly -- at least, at a minimum -- be our assumption.

MR. GRIFFON: Arjun?
DR. MAKHIJANI: This -- this limit of detection thing, on page 79 of the TBD, Mark and I were -- were you going to ask about that?
MR. GRIFFON: Go ahead.
DR. MAKHIJANI: Well, you -- you say that the limit of detection was .1, but there was confidence in readings equal to .5 picocuries per liter. I don't know what that means, if the -- and how -- since most of your readings are between .1 and .5, where does that leave us in terms of confidence?
DR. NETON: I think what -- what you're seeing there is the confidence that these are actual true -- true radium-derived body burden estimates and in fact that the concentrations -- the body burden may actually be lower than that, but there was confidence that these values would certainly represent some type of radium intake.
The detection limit, by the way, cited in the profile, .006, really is the detection limit I believe that was used by the Massachusetts Institute of -- MIT and the HASL detection limit really is .1 -- it's fairly well

established in their documents that it's .1.

MR. GRIFFON: And can -- I'm trying to also understand the -- would the -- to develop the radium/uranium ratios, you considered -- I wonder if these were even going to come into play. Anyway, you considered the -- the -- the entire cohort from the CER database to do the radium ratios. I assume you did the same for the uranium.

DR. NETON: That -- that's right, the entire CER dataset.

MR. GRIFFON: CER database, and I -- I was curious whether any attempt was made to look at the subsection of the uranium CER database that would apply to those people that were analyzed via radon breath monitoring. I mean it seems to me that you should compare apples and apples to establish this ratio. I'm not sure that it's intuitively obvious which way it's going to take the ratio, quite frankly, but I'm just -- just throwing that out there that -- I don't know.

DR. NETON: Well, I would think that it would increase the uranium -- uranium intakes would be higher in the production areas of the plant

that weren't -- yeah, I mean if -- if plant -- if you're working with uranium metals, your uranium intakes are going to be -- I mean the process of -- of uranium. So if we've included that, our uranium intakes --

MR. GRIFFON: My -- my sense -- I'm not sure exactly who got radon breath monitoring, but I've heard you guys tell me again and again that the people that worked with the residues were being pretty favorable because all this stuff was wet processing, so the chances of ur-- a lot of uranium dust are probably lower in those areas than maybe in other -- that -- that's what was going through my mind --

DR. NETON: Agreed.

MR. GRIFFON: -- as I was thinking --

DR. NETON: Agreed.

MR. GRIFFON: Is -- so if that was the case, then you could have higher uraniums in your overall database that are driving the ratio the other way.

DR. NETON: But that was the reason that we went with the radon breath measurements because you -- you independently calculate a uranium intake, and then you're not applying any ratio

to come up with the amount of radium, and we still have this issue that Arjun raised about thorium 230, I'll grant that. But -- but the radium breath -- the radon breath data gives you radium intakes independent of whatever the uranium intakes were.

MR. GRIFFON: Right, so that -- that's what I -- I started this discussion by saying I'm not sure it's relevant anymore 'cause I don't think you used -- but --

DR. NETON: Well, if this approach were used, that's true.

MR. GRIFFON: Right, right. And -- and so the radium/uranium ratio in this report was really considered just to validate it against other ratios like the silo ratios and things like that. Is that part of why you presented the radium --

DR. NETON: Well --

MR. GRIFFON: -- to uranium ratios?

DR. NETON: -- the whole full -- the full progeny ratios are presented, but we are definitely proposing to use the ratios beyond radium for those portions of the decay series.

MR. GRIFFON: Right.

DR. NETON: So the silo -- the silo ratios are relevant if you use radon breath beyond radium. I mean you've got lead and polonium and those -- those isotopes, radionuclides. But the -- the analysis, as you can -- as you can read the document, you've all -- we're trying to establish these ratios and how you do the dose reconstructions and then -- you know, the ratios are established if we were not going to use radon breath, but then after we decided, looking at the data, that radon breath were more appropriate for the K-65 workers -- you're right, the ratios are not as relevant for uranium to radium, but certainly from radium to the other progeny is -- is still relevant 'cause we have to -- we have to be able to infer the doses -- the intakes for those nuclides.

DR. MAURO: Jim, I have a -- I have a -- it's a really relatively simple question in that -- I know we've been focusing in on the -- the radium body burden and the radon breath, but let's -- let's go back to the worker who worked with ore, whether it's pitchblende or American ore. And you have a high level of confidence

that that's what he did. Okay? There may be some possibility that on occasion he may have worked with some of the residue material. Okay? And you have urinalysis data for him. Okay? And that's it. And you've got the fluorometric analysis, you know what the ur-- the radi-- the uranium is in the urine and now we're going to say okay, well, what are we going to assume about this fellow's exposure to other radionuclides, specifically radium? Now I could see two paths being taken. One, we'll assume the one to one ratio, equilibrium with the -- or alternatively, you're going to -- here's where the judgment comes in. This is tough call. If -- looking at his work history there's some ambiguity about whether or not he did -- he was exposed to some residue. Right now is it your inclination when those ambiguities exist, would you say yes, he got his uranium plus the 95 percentile on the radon breath, or the one to one ratio with the radium? In other words, it's going to be a tough call on criteria for parsing out that circumstance. Have you -- have you given much thought on what kind of guidance you will be

giving to your dose reconstructors on dealing with that situation?

DR. NETON: It's a tough question because it depends on the situation, and you give some -- you give an example, but it's hard to say from an example how we'd do it, but certainly he would at a minimum get the one to one ratio. But I suspect that if we were not able to definitively position this worker only at one to one but he had the potential for much higher, we would give him the 95th percentile. We're always going to err on the side that is the most defensible, and in that case it would be the 95th. The distribution of doses would be for someone who -- who was sort of an ancillary worker that was not near the process equipment that was generating some of these dusts and that sort of thing.

MR. GRIFFON: Just to -- just to go back to the radium/uranium ratio for a second -- last question on this sub-- just to understand for myself, you -- you won't -- there's not a case now that you -- that you can foresee where you would use the urinalysis data and just apply those source term ratios --

DR. NETON: Well, I --
MR. GRIFFON: -- I mean you'll use the radium data or the radium coworker dataset all the time to generate your radium intakes?
DR. NETON: That's our intent right now.
MR. GRIFFON: Okay.
DR. NETON: Now we do need to go back and -- and look at this issue that Arjun raised with thorium 230 because --
MR. GRIFFON: Right.
DR. NETON: -- it is a little bit vexing, but I think the -- you know, we need to look at more than just the fact that thorium 230 is there. We need to look at the concentration of thorium 230 in the source term and is it even plausible. We know the ratio of uranium to thorium in say the airport cake, and it creates very high ratios. But one needs to look at how much was there. And given that amount of projected uranium intake, a person were required to inhale fairly substantial quantities of airport cake, we need to -- we need to look at that to use it as a bounding -- bracketing scenario. So my cautious answer is yes, we intend to, but -- you know, I'll never

say never while this is evolving.

MR. GRIFFON: Any other questions on 1(d)? Anybody have any...

What I was going to propose after this is to move into item 6 and have you guys present some of these cases. I think it might be good to go from 1 to 6 because most of what you're going to describe in 6 I think continues --

DR. BEHLING: (On telephone) Mark, can I interrupt? We're still getting a very inaudible and fragmented reception for those of us who are on the phone. Either there's a problem with the microphone or people are not speaking into the microphone.

MR. GRIFFON: Sorry about that, Hans. Is that better?

DR. BEHLING: Yeah, you're coming across loud and clear and so is Dr. Wade, but whenever Jim Neton and Mauro and -- and others have been on the microphone, it's very, very fragmented, words at a time, at best.

DR. MAURO: Hans, this is John Mauro. Can you hear me now?

DR. BEHLING: Yes, I can.

DR. MAURO: Okay, so the problem is I've just

not been speaking loudly and directly into the microphone.

DR. NETON: And I guess that's the same thing -- can you hear me, Hans? This is Jim Neton.

DR. BEHLING: Yes, I can. When people speak directly into the microphone, it's not a problem, but as soon as they withdraw, even by a matter of inches, then everything becomes very fragmented.

MR. GRIFFON: Okay, we will try to pay attention to that, yeah.

DR. BEHLING: Thank you.

MR. GRIFFON: All right. So I think we're ready to move on to item 6 --

DR. NETON: All right.

MR. GRIFFON: -- if you guys want to --

DR. NETON: We have prepared -- this is going to be difficult to speak directly into the microphone when I'm using props, but we have prepared four dose reconstructions, and actually these were done by Joe Guido. I'll set the stage here and then maybe let Joe flesh out the details of what we have here.

But this was a case where -- item 6(a), it indicated where we had urine, air and breath

radon data, how we would do a dose reconstruction. So here we have a worker who -- as an example case -- may have had a prostate and a colon cancer. The person started work in '51 and -- and completed their work in 1958. So we pulled out from the database the person -- in our NOCTS database, our claims tracking system -- is listed as a chemical operator, and here you see Joe has pulled out the designations that appear on the various dosimetry data forms that -- that are available from the database. And one can see that this person worked in a variety of different positions, even though one -- he's ostensibly a chemical operator. And I think the chemical operator designation actually comes from what's on the EE3 form, the claim form that's filled out by the claimant. So we can see that he worked as a furnace room person; a fork truck operator; dingot, which would be uranium metal; cleanup; ore room -- that sort of thing. Data summary -- briefly, we do not deal much with external dosimetry data in these -- in these reconstructions, but you can see this person had a deep dose of -- of 10 rem

recorded. Now that would indicate -- that type of exposure would certainly indicate potential for exposure to raffinate type materials where you have disequilibrium of radium and uranium. And we had no thorium bioassay on this person, although we didn't have any reason to believe that he was working in Plant 7E, which is where the thorium processing work was done. And there were seven breath radon samples that ranged from ten percent of tolerance, which is .1 picocuries per liter, up to .18 -- that's an odd num-- that must be an average -- yeah, that's the average, up to 30 percent of tolerance.

And here we have a number of uranium sample results, most of which were above the detection limit, and you can see that this person was -- was excreting fairly consistently, over a five-year period almost, fairly large -- by today's standards, fairly significant quantities of uranium. The detection limit here I believe is ten micrograms per liter -- is that right, Joe? So anything less than 9.5 picocuries per day excretion would be undetectable and he only had a couple of those. There's a few fairly large

intakes, doses, in April and July of '53. This is a summary of his radon breath, as you see it.

And then we get down to the approach. It's very consistent with what we've been talking about earlier today. Joe modeled his uranium intake from his bioassay data, his radium intake from the radon breath monitoring data using this document which I provided a copy of to interested stakeholders of OTIB-25, which is the -- sort of the historical and rationale behind converting radon breath measurements into body burdens. The progeny intake were normalized to radium based on the ratios that we described from the Fernald silos. And here we have the ratios that were used.

So one gets down to this relevant column, which is the intakes, and you can see that a chronic intake was -- was projected based on the bioassay for uranium of about 510 picocuries per day. There -- there is this acute intake that's been modeled, and that is so that one can be consis-- have the -- have the data fit the available information properly. You have to -- you have to have had a fairly good acute

intake early on for these data to fit the chronic model, so you end up with this 1.8 times ten to the fifth. It sounds like a lot higher than the chronic, but if one takes the chronic intake at 510 picocuries per day, you end up with about an equivalent amount of intake per year now from that point on. It's about 1.8 times ten to the fifth picocuries per year intake, which is very much in line with what one sees in the site profile for -- for different types of jobs for time-weighted average, ten to the fifth, ten to the sixth is -- is fairly consistent.

The radium breath -- radon breath measurements ended up projecting a radium 226 intake of seven times ten to the fifth picocuries -- well, 4.4 times ten to the third picocuries per day in a chronic model, so that gives us 4.35 times ten to the third times 365 -- gives you a 1.6 times ten to the sixth picocurie intake of radium 226. So you're in the microcurie range of intake here. Fairly -- fairly substantial radium intake based on the radon breath model. Now let me explain a little bit about how that calculation comes about. You have a radon

breath intake that projects a radium body burden at that time, how much radium is in the body. One then has to run the IMBA -- the models backwards and calculate what amount of radon -- radium could -- should a person have breathed in to result in that type of body burden, and that's -- that's how you get intake. It's just a standard back calculation of bioassay data to intake. So that's how that value is arrived.

Now you see the thorium 230, polonium 210, protactinium and actinium intakes are all ratio'd directly to the radium intake using the K-65 silo material at Fernald.

I'm not sure they show up real well on your -- your -- your handout, yet -- Arjun?

DR. MAKHIJANI: Yeah, now in this specific case -- I mean if you look at the work history, the guy worked in the ore room and also had gang lead cake, so that would be the K-65 stuff. I don't know what -- I've forgotten what RAF means, what is RAF?

UNIDENTIFIED: (Off microphone) Raffinate (unintelligible).

DR. MAKHIJANI: Raf-- so that's -- all cap --

caps, okay. I've not seen it in all caps before. The -- sorry.

MR. GUIDO: Sorry, I just tried to be honest to exactly the way it was written in the CER database. That doesn't mean someone else didn't transcribe it some other way. But I tried to be honest to the way it was actually just in that database.

DR. MAKHIJANI: Yeah. No, I'm just taking this at face value, assuming everything is correct. And so if I -- if I look at this and say pot room, ore room, raffinates -- which would have more thorium than radium, gang lead cake -- which would have more radium than thorium, ore room -- which would have equal radium and thorium, then how do you decide that the K-65 -- so this is a specific question. So if you apply a one to one ratio and say this guy worked with ore most of the time, then you'd come up with a much bigger thorium number.

DR. NETON: Arjun, this is about the third time we've talked about this, but you know, we acknowledge that the thorium 230 number needs to be worked out, and it's still our position that these values are bounding or are likely

bounding. We need to go back and document this, and I'll -- I'll give you the credit that it may not be, but we believe they are, based on certain parameters. For instance, we have projected that this person has a thorium 230 intake of 545 picocuries per day, so he is receiving a 1. -- a two times ten to the fifth picocurie of thorium 230. Now we need to go back and look at the source term material for the other, the -- the ore -- the -- sorry, do I have those? (Unintelligible)

What I'm suggesting here is -- is we've -- we've assigned a ten to the fifth picocurie intake of thorium 230. We need to go back and look at the airport cake and those other waste streams and say is it plausible that a worker can have a ten to the fifth intake of thorium 230 from a waste stream that has X picocuries per gram of thorium 230, whatever that is. So there are physical comparisons that need to be done here, and I'll acknowledge that that's the case.

So the -- the bioassay projection models here are essentially -- you know, the fit of the data -- I apologize, you probably can't see on

a black and white graph and our -- I assume this is right out of our IMBA software. It's not very graphically friendly. I mean it gives you a feel, but you can see the line going through the data points here. These were modeled as chronic -- chronic exposures. Now let's get over to what's of interest here, the dose table. Based on this level of intake, we -- we have provided the -- or Joe has provided the -- now these are not annual doses, either. It gets very difficult to provide individual annual doses. Those actually were used in the probability of causation calculation run. These are a summation of the doses from the date of first exposure to the date of cancer diagnosis, which is the relevant period that we do for all dose reconstructions. One can see that there is a fairly substantial dose from -- I'm having trouble with my bifocals reading this slide, but polonium 210 gives about 6.7 rem dose to -- this was calculated to what organ here?

MR. GUIDO: (Off microphone) Colon.

DR. NETON: Is this the colon dose? Yeah, colon dose, I'm sorry. So this is the first

cancer that was in the file, so we end up with a total dose of about 18 rem to the colon. And then if one models the dose to the -- what we call the highest non-metabolic organ, that's the organ that doesn't concentrate any of these radionuclides, you end up -- I'm sorry, 12 rem to the colon and about 18 rem to the highest non-metabolic organ, which in this case would be the prostate gland -- you end up with probabilities of causation in the vicinity of 20 percent for the non-metabolic and 26 percent for the colon. So these are fairly substantial doses, but the PC -- it's not low, but it's not past the 50 percent threshold, even given some of these fairly large intakes.

If one goes down and looks at the -- now using the same data, the same input data, and one wants to infer what the doses to some of what we call the metabolic organs -- the dose to the liver, the bone surfaces and the kidney -- this is as we've seen in many, many dose reconstructions. The doses to these organs are significantly higher, 2,300 -- 20 -- 2,370 rem to the liver, fairly substantial dose.

I -- I -- under almost any circumstance, these

-- these values are well above 50 percent. I don't know if we have the -- you didn't do the PC values for -- it's -- it's -- for those of us who work with these numbers a lot, these values are all well above 50 percent. Bone to -- dose to bone surfaces, 17,300 rem. The dose to the kidney is 173 rem, so very much in line with what we've seen at many other facilities in situations where you have very large intakes projected, the metabolic organs are well above compensability and the organs that do not concentrate the material don't get there.

Now I will say that we have not included any external dose in this calculation or any missed dose due to external, nor have we included any dose from systemic radon, whether it's particulate or gas. We -- that's a subject of another issue here, but that was unlikely to raise these doses much higher, though, as a -- for a practical matter. These are so large, the radon doses sort of get lost in the round-off here, but -- so that -- that's the first case.

I don't know if there's any questions on this. This -- these would all change, of course,

depending upon the ratios that were used relative to the -- you know, the source term.

MR. GRIFFON: Just looking at the --

DR. NETON: Arjun is very correct. I mean you look at thorium 230, it is the -- it is the driver of the dose here for the metabolics of 100 -- 100 rem out of 173 rem for the kidney. For the non-metabolics, thorium 230 is eight out of 17 or 18 or so, so it's -- what surprises us -- what surprises me was the polonium 210 value, 6.7 rem. I would have not guessed that, you know, at the start of the calculations.

MR. GRIFFON: Can I -- just a question on the radon breath table?

MR. GUIDO: Sure, go ahead.

MR. GRIFFON: Why -- you have three listings of percent tolerance.

MR. GUIDO: The CER database in -- has --

MR. GRIFFON: Right.

MR. GUIDO: -- two columns of data for each -- an analysis date, and generally the first column's populated -- once in a while, as you see on this individual, there's two data points per date.

MR. GRIFFON: So you averaged --
MR. GUIDO: So I averaged those. Going to add, too, on this case that the ten rem of external would have -- would make this go over 50 percent. This -- this individual -- this person has ten rem of external dose, and even without the modifying factor, that would -- that would be enough, but I didn't include that in the POC values.
DR. NETON: Yeah, 'cause the doses -- internal doses stay the same, but you're -- you're sure ten rem would put those over?
MR. GUIDO: Yeah, 'cause they're going from ten -- they're -- the thing about this case is it's two cancers, so each one needs to be --
DR. NETON: Right, yeah --
MR. GUIDO: -- (unintelligible) 30 percent --
DR. NETON: -- I think we're trying to keep that a separate issue, whether it's two cancers or not. We're trying to look at the individual cancers here because that's really what we're -- yeah. I mean this is an example case and we're not trying to decide whether this pers-- this particular individual has any compensability, so -- but I think -- I think if

we took the individual cancers at face value and added ten rem, it would be my guess that they would not go over --

MR. GUIDO: No.

DR. NETON: -- 50 percent. But -- you know, 'cause it -- it's not a linear function, as we all know.

I'd just like to point out a couple of things, is one is that the intakes that were projected here are fairly consistent with the Table 29 values for -- for time-weighted averages, although arguably a little higher. They certainly aren't lower, and I -- I think if we actually used the time-weighted average value to estimate intakes here, we would have likely had a smaller dose -- in this particular case. I -- you know, it's -- it's very difficult for us to generalize to all cases. It's just not possible. But in this instance, I would say the radium intake by itself is about there. The uranium intake is about equal to Table 29 values. But when you put them together, you end up with a slightly higher intake because we have separate estimates of intake. And again, I -- you know, this -- and that's -- that's

just for the radium and the -- and the -- radium. You start adding in the thorium 230 source term of ten to the fifth picocuries per year, you end up with some fairly substantial intakes here.

DR. MAURO: Just for clarification, if you were to use -- now what I understand is if you were to be using the previous method, you would be -- the approach would have been to assume the -- you would have used the urinalysis for the uranium and, given his job descriptions, you would have assumed 100 times that concentration for radium in the urine, and then back-calculated what the intake would have been.

DR. NETON: Right.

DR. MAURO: In this case you're going with the radon -- the actual -- for this worker you have radon exhalation data --

DR. NETON: Right.

DR. MAURO: -- and you have some value for what the radium body -- and you're saying that's what makes the difference, along with some of these other ratios you used --

DR. NETON: Right.

DR. MAURO: -- so that we had a small

difference. Now, the question becomes if this worker did not have radon breath analysis and you would have had to have gone with the 95 percentile, would that have had a substantial effect on the dose and the amount of radium taken in?

DR. NETON: You make a good straight man, John. That's my next example.

DR. MAURO: Oh.

MR. GRIFFON: (Off microphone) I figured that was (unintelligible) ask for one of those.

DR. NETON: We didn't rehearse that.

MR. GRIFFON: (Off microphone) But there it is. Right?

DR. NETON: It's our next example, but -- so -- it's -- it's a good point, though. You raise a very valid point here.

One thing I'd like to point out, though, is -- and Arjun brought this up. If you look at this person's work history, it's pretty clear that he worked in a lot of different areas that were raffinate, no raffinate, maybe some thorium higher than radium -- it's hard to say. This guy was all over the place. I bel-- I suspect that, you know, based on the time-weighted

cards we have on a person like this, we could apportion based on time. It gets to be very unwieldy, though, and -- and then one gets down to exactly how closely do you parse these people's work histories out. I mean because we have it doesn't necessarily mean we have to use it all, you know. I mean it becomes very cumbersome at some point.

So let's -- let's move on to number two, which is exactly the same case, but we -- Joe assumed that we had no -- we just didn't have access to the radon breath data. Where is it?

MR. GUIDO: Make a comment there --

UNIDENTIFIED: (Off microphone) (Unintelligible)

DR. NETON: I've got -- thank you.

MR. GUIDO: -- in looking for these cases for -- for active claimants we had all the data on, I could not find one that was, you know, clearly a ore/raffinate worker who didn't have radon breath. I had to go this route. Not that there isn't one out there, but I looked through the 129 claims we had and couldn't find it, so...

DR. NETON: Okay. So this -- the demographics

on this case are identical 'cause it's the same case and we had all the same information, same bioassay for uranium in urine, applied the same ratios, got the same uranium projection -- although I'm not sure it's not just a cut and paste of the original analysis. But what we did was we did not have -- what, did I miss something here? I want to show the -- okay, there's the uranium in urine. Okay, the approach, uranium intake from uranium bioassay, radium intake from 90th (sic) percentile of CER radon breath analysis, and then the progeny were normalized to radium. There's the ratios, and there's your projected intakes based on the 95th percentile. And you see he has 8.78 times ten to the third picocuries per day, so they -- he ends up with about 3.2 times ten to the sixth picocuries intake per year of radium 226, which is higher than I think the first case, but not ridiculously higher. I mean it's in the same ball park.

Now that -- that shows you the radon breath ranges give pretty high projected intakes. I mean 'cause the sensitivity of this technique is not -- it's better than some cases, but it's

not as good as whole body counting, for example. You can get down much lower.

DR. MAKHIJANI: (Off microphone) (Unintelligible)

DR. NETON: That was using the 95th percentile of -- of the radium.

So anyways, let's move on to the doses. This would be --

DR. MAURO: Jim, I'm sorry, this is John Mauro. When you pick the 95 percentile, you work with the entire population of radon breath data --

DR. NETON: Correct.

DR. MAURO: -- and not try to parse it in any way.

DR. NETON: No.

DR. MAURO: Okay, thank you.

DR. NETON: We've looked at that. It's very difficult to parse those values. We have 2,500 samples. Once you start breaking it out by job description, it -- it's tough to do.

The bottom line dose here is that his colon dose is now 22 rem. I think it was what, 12 rem before? His dose is about doubled here. And I suspect, as Arjun has pointed out, much of it is due just because of the larger radium

intake, which has jacked up the amount of thorium intake.

As a matter of fact, let's go back and look at that thorium intake. Yeah, if you -- if you have more -- his thorium 230 now is 1.1 times ten to the third picocuries per day times 365 -- it should be about double. I'm having trouble with my calculator. Yeah, he's at four times ten to the fifth, I think you've got two -- so it's about -- it's a little -- again, Arjun has correctly pointed out thorium 230 is a driver nuclide here in these calculations, very sensitive to that. But again, we're assigning a four times ten to the fifth picocurie intake of thorium. We need to do our homework and come back and convince folks, as we believe, that these values are plausible bounds of thorium intakes for these workers based on the other waste streams. That's -- that's what we need to do, and I totally agree with that. I totally agree we need to do that. Okay. So again, even though the dose has doubled here, neither -- neither of the colon nor the prostate gland are above 50 percent. However, I'm not convinced if you add in -- you

might add in the ten rem plus missed dose and be over 50 percent. I'm not sure that's the relevant part of this conversation. I mean that -- these are just how they came out. I don't think we need to model these doses to where the PC comes up. It's just for information only.

DR. MAKHIJANI: But if you take this specific example and you add up the probabilities of the two cancers, in the first case where you had the data, the person is non-compensable. And in the second case where you don't have the radon breath data, the person becomes compensable. No?

DR. NETON: (Off microphone) He was non-compensable under both cases.

DR. MAKHIJANI: Oh, you don't add up the probabilities.

DR. NETON: Speaking if they were individual cancers, the pers-- the individual cancers themselves, if taken separately, were non-compensable. If they were taken collectively, I believe they would have been compensable under both scenarios.

MR. GRIFFON: But I -- I think his point stands

that --

DR. NETON: But the point is that --

MR. GRIFFON: -- the POC is doubled with -- when you don't have the data. Right?

DR. NETON: Right -- well, I think this is -- this is something that is -- is -- is an issue with this program. The less you know, the more you have to infer. And when we infer in a claimant-favorable, that's what happens. I mean --

MR. ELLIOTT: But these examples weren't designed or derived to demonstrate compensability. These examples were designed to answer the questions that were raised at the Board meeting that -- and we were charged to come back to you all with answers for, demonstrate how we would treat certain data streams.

DR. NETON: But -- but Arjun is correct in pointing out that where we have workers who should have been monitored and weren't and we -- we estimate doses, the doses will be higher. And this is not necessarily just relevant to Mallinckrodt. It's relevant across all the dose reconstructions we've been doing.

DR. WADE: Denise?
MS. BROCK: I just want to make sure that I understand. When you have two separate primaries, when I looked at that I guess I was thinking, too, that you add the two together, even though we're not discussing compensability. Is that correct, though, you --
DR. NETON: Right.
MS. BROCK: -- you add the two together.
DR. NETON: They're both considered. It's not additive, but you're right, they are -- they are -- there's a formula that we use to --
MS. BROCK: Combine it.
DR. NETON: -- combine them.
MS. BROCK: Okay. Thanks.
DR. NETON: Yeah. We just wanted to segregate those, just because we're not really discussing compensability here.
Okay. And then if one looks at the alternative organ doses that -- that Joe has calculated -- liver, bone surfaces and kidney; these are what we would call metabolic organs -- the doses have gone up, as well, and -- about doubled, and again, these dose-- these organs are all

compensable, you know, under both scenarios. Well, the doses are very high under both scenarios. So that -- that -- it demonstrates our -- our approach when we don't have radon breath data and we have radon (sic) in urine data.

Okay, any -- any other questions on this -- this specific case?

DR. MAKHIJANI: (Off microphone) (Unintelligible) Is Joyce on the phone and does she have any questions?

DR. NETON: I'm not sure. I'll speak directly into the microphone. Arjun has asked if Joyce Lipsztein is on the phone and she might have any questions.

DR. BEHLING: (On telephone) No, Joyce -- I got an e-mail from Joyce -- this is Hans Behling --

DR. LIPSZTEIN: (On telephone) I -- I'm in (unintelligible) Hans.

DR. BEHLING: Oh, okay, you are on --

DR. LIPSZTEIN: (Unintelligible) yes, I'm on. No, I don't have any questions now. I think that's okay. When you -- I don't see the slides you have (unintelligible), Jim, but when you back off the (unintelligible) radium from

the radon in breath, so you took an account of how many years the guy had been working -- right? -- for the cumulative radium in the bone?

DR. NETON: We did this -- Joyce, we're having a lot of trouble hearing you, but I think your question is did we take into account the number of years the person was working, and we did this on an annual basis. The radon breath was assigned per year based on the values that were measured or inferred.

Is that right, Joe? I think that's what you did.

MR. GUIDO: Yeah. Yeah, I wasn't sure what her question was. I mean I know this -- the one thing that's strange about this --

DR. NETON: Speak directly into the mike.

MR. GUIDO: One thing that's strange about this case is the radon breath data is only available for the first -- what is it, the first four year-- three years of employment, and yet we gave him -- that's the exposure based on a chronic, and extended it all the way out to the end of the employment. So I wasn't sure if that was your -- your question about the

duration of the exposure. It was for the entire employment period, even though the radon breath monitoring ended, you know -- and one could postulate why, but you know, you really can't determine a good enough reason to turn off the dose, as we talked about earlier. So does that -- does that help or does that totally miss what you were asking?

DR. LIPSZTEIN: It's very -- I can hardly hear you.

MR. GRIFFON: (Off microphone) She can't hear you.

MR. GUIDO: Well, I can talk a little louder -- I can talk loud.

DR. WADE: Go ahead.

MR. GUIDO: I'm not sure if the answer to your question is -- you know, in this specific case the radon breath monitoring data was only present for the first three years, yet the intake that was assigned was assigned -- you know, using that data for the entire employment period. So -- I mean is that an answer to your question, 'cause we were -- or not?

DR. LIPSZTEIN: Yeah, yeah, because I was thinking -- I was -- what I wanted to know is

that if you considered each -- as if it was just one year intake or the whole life because the radon would accumulate in the skeleton so what you see from the radon badge would (unintelligible) his whole working period.

MR. GUIDO: Right, for -- so for this intake assessment we used the -- the three years -- so it was based on the three years of data, so we didn't postulate any data further out, but we did assign a chronic intake and it -- you know, it continued on beyond -- but the -- but the level of the chronic is based on the three years of data.

DR. LIPSZTEIN: Oh, okay. Okay, that -- that was my question, yes. Okay.

DR. NETON: Okay, should I move on to example three then?

All right, the third -- the third example I think has to do with the thorium workers, and we haven't discussed this much. By thorium worker here, we mean people who worked on the special project in Plant 7E, I think it was, to -- to take the airport cake which had thorium 230 in it and concentrate it to ship to Mound. Now this was a -- a wet chemical process that,

to the best of my knowledge and looking at the data, never took the material to dryness. This was a thorium nitrate solution I think was actually what ended up being shipped to Mound, but it was -- the task at hand here was we have a thorium worker. We had uranium and thorium analyses and radon breath, which I'm not sure was relevant here. Let's see, this was to -- example internal dose asks for Plant 6 -- Plant 7 thorium extraction worker.

So it turns out then in looking through the database, we have found I think it's about 70 bioassay samples that were analyzed for thorium 230, and specifically for -- for workers -- I believe they were in Plant 7, although there might have been an indication that some of these workers were Plant 6 and moved over to 7, but in this time frame these were HASL results in the data files for workers. So we have 70 bioassay samples. This particular person has a bioassay sample, so let -- let's just go through this.

Ionium of course is the historical name for thorium 230. This particular case had a pancreatic cancer, who started work in '49 and

ended shortly -- '58 plus with a break in employment at one point. This was a laboratory technician. He had -- his dosimetry data indicated he was a chemist, a Plant 7E worker, a technician, a process Plant -- so there's a lot of indication here that this person worked in Plant 7E where the thorium extraction process was done. He has, again, a fairly high external dose, 8.2 rem, which is consistent with working with some material that had some high photon activity rather than just straight uranium.

There was one thorium bioassay sample that was -- the result was 1.4 disintegrations per minute per liter. The person actually did have, it looks like, seven radon breath samples, which is interesting. So -- he also has uranium bioassay. So here a worker has a number of uranium bioassay samples; in the early days many of them above the detection limit, and after 1955 they were all less than detectable. Here is a summary of the radon breath data that appears to be increasing over time, somewhat substantially -- ten, 20, 40, 20, 60, so that's interesting. And now we have

thorium in urine data, so if we -- and we used the -- these ratios -- okay, the approach, we analyzed the uranium from the bioassay data, the radium intake was from the breath data monitoring. The polonium was intake -- normalized to radium based on the ratios, and then the thorium intake was from thorium bioassay. So you're going to have to explain some of these normalized ratios that you used, I think, 'cause I don't think we've gone over these before -- Joe or Cindy.

MR. GUIDO: Yeah, you mean the -- those are basically the ratio to radium or the ratio to thorium, and so I guess the terminology I used, when I said normalized, that's just basically you're applying those ratios. The polonium isn't present in -- the -- the thorium ratios don't include polonium, so I went ahead and put it in, at least on the radium 'cause there was radium -- radon breath monitoring. And this, again, is an example of being very claimant favorable because here -- the person -- if you look at their data on their card, they're clearly a -- a 7E worker. I mean they -- they worked -- I mean most of the data was tagged

Plant 7E. However, there was radon breath monitoring data, so we went ahead and said well -- we gave him the radon -- the radium exposure from that scenario, also. So it's probably double -- double -- you know, giving him twice of some things, but you can't really split it apart to say when he did one and when he did the other.

DR. NETON: Okay. So here is the projected intakes -- (unintelligible).

DR. MAKHIJANI: I just -- I just want to understand these numbers. So what you did is you just carried the radium through the '58 from the time that there was the radon breath data and then the thorium 230 for '55, '57, you derived from that one --

MR. GUIDO: Exactly.

DR. MAKHIJANI: -- sample.

MR. GUIDO: Exactly.

DR. MAKHIJANI: Now how does that work when you have one sample in the beginning of the period, when did production start, how did production progress in terms of its volume, because that seems to me right in the beginning of the period. Right?

MR. GUIDO: Yes -- yes, it is. Well, it was assigned as a chronic intake with the -- you know, using that one sample 'cause that's -- that's the only data we have for it, so...

DR. NETON: So you raise a point, this was early -- earlier on in the process, but you know, what amount of intake per day would it take to get up to that value, given the amount of time that -- that the person had -- had worked. Here's the radium bioassay projections fit. There's the uranium projection.

And then let's look at the dose to the pancreas. This is 110 -- the rem dose to the pancreas, 75 percent of the dose is contributed to by the thorium 230. The rest of the intake values are very low contributors to this person's pancreatic dose.

Now at 110 rem, this person -- if one were to do a calculation, PC is right at 50 percent.

Now if we look at the alternative doses, what we call the metabolic doses, we've got the highest non-metabolic actually in here at 130, and that's -- that's going to be similar to the dose to the pancreas -- it should be, I can't -- it should be right -- well, very close. Now

the dose to the liver, the bone surfaces and the kidney are much, much higher, which is what you'd expect for an organ that concentrates, to some extent, thorium 230. Although interestingly, the -- the bone surface dose is also driven, to a large extent, by the actinium 227, which is not a surprise -- a fair amount of daughters, progeny, related to actinium 227 that are alpha emitters. Actually that's the largest component of the dose, isn't it? Yeah, so that's the --

DR. MAKHIJANI: Jim, in the site profile, in Table 29F, it says that the thorium production started in July 1955 and your sample's from April '55.

MS. BLOOM: We definitely have information that they started in March --

DR. MAKHIJANI: (Off microphone) Okay.

MS. BLOOM: -- of '55, so I'm not sure if --

DR. NETON: That may be production --

MS. BLOOM: -- if that was better --

DR. NETON: -- versus --

MS. BLOOM: Yeah.

DR. NETON: -- pilot operation.

MS. BLOOM: Yeah. But the program did start up

in March. It -- it didn't start before 1955, in January, but we definitely saw something that indicated March was the start-up date.

DR. NETON: Now one point of interest here, I suppose, if one looks in these values at the ratio -- 'cause remember, this is airport cake material. One can look at the ratio of uranium to thorium in these samples -- or in these projected intakes, and they vary over time, but the projected uranium intake is about 300 picocurie. These are per day, I assume, here. So you know, there are some fairly large discrepancies here of thorium, but again, this was a -- this was a process that was concentrating the thorium into a thorium nitrate solution. So these are not necessarily relevant to the -- the airport cake product itself, but I think one doesn't see a ratio higher than 100 to one, probably. Yeah, so you know, you're below 100 to one ratio here, which I think is not that inconsistent with some of the airport cake material.

Again, we need to -- we need to look at the airport cake material and see what the actual concentration of thorium 230 was in the source

material and the plausibility of getting higher intakes than -- than what we've estimated for the radium guys.

Okay, I think case three -- or four -- I've actually forgotten what case four was, but it's a thorium worker where we have no bioassay -- or without thorium bioassay. We have uranium and breath, and the uranium and breath calculation, of course, would end up being the same. And the thorium and protactinium are normalized to uranium intake based on ratios. I think this -- this is where you applied this ratio, Joe?

MR. GUIDO: Yeah, there's a -- there's one point of clarification here. The thorium -- this individual has four intake periods bec-- one of it's because there's a break in employment and such, but for the '55 to '57 period, which would be the period of the thorium operations, for this case we said well, again -- you know, this is a thorium worker, but we don't have thorium data. So what we did is the thorium 230 is based on 100 times the uranium, and that did not make it into the approach paragraph there, I apologize for that.

But that's where -- that's the only difference between this case and the others. The examp-- so the purpose of this is just to demonstrate what would we do if we're convinced it's a thorium worker but we don't have thorium data, so we give it the 100 to one ratio, which is going to make the exposures higher.

DR. NETON: Now what is the basis for the 100? You might want to explain that.

MR. GUIDO: Yeah, that's from the -- the document here. You know, we're saying what the ratio of thorium 230 to uranium and -- where did those numbers come from, Cindy?

MS. BLOOM: That's based primarily on our initial look at the AM-7 -- the -- the airport cake.

DR. NETON: Right, okay. So in this particular case, using that 100 to one ratio to uranium, the bioassay projections are the same, the doses are presented here and again it looks like they about doubled over what was projected without bioassay. Thorium 230 is driving the calculation with 100 -- 200 rem out of 227 total, and the PC value of course is well over 50 percent in this case -- 67 percent.

If one looks at the alternative organ doses -- not the -- well, the -- the non-- that's the non-metabolic one I just showed. These are the metabolics and these are all of course higher than the last example, and the PC -- well, we didn't calculate PC value, but they're all -- they're all very substantial doses. For the most part, when you get above 100 rem or so, it's pretty -- depends on the case, but 100 rem will certainly get a PC of 50 percent or greater for most -- most calculations. I think I'm safe to say that. So again, the metabolic organs under this scenario are also compensable.

But what we have here is a picture of some fairly substantial intakes. We knew that Mallinckrodt was a messy operation. These intakes are large. It's not surprising that they're -- they're coming out large with very large doses. That's what we expected.

MR. GRIFFON: Okay, I think we can -- if there's no more questions on the cases, I think we can go back to the -- to item number two, which is the handling of the radon exposures. Jim, maybe you'll --

DR. NETON: Okay.

MR. GRIFFON: -- give us an intro.

DR. MAKHIJANI: (Off microphone) (Unintelligible) Joyce (unintelligible).

DR. NETON: Joyce, are you still on the phone?

DR. LIPSZTEIN: I'm still on, but I can't -- now I can hear you. I couldn't (unintelligible).

DR. NETON: Okay, I need to speak loudly, I guess, because we want to make sure that you hear -- hear what I'm saying.

DR. MAKHIJANI: Joyce, this is Arjun. I -- I sent you that little list. I don't know -- I'm relying on you here to ask the questions mainly, and I'll fill in, but -- so please speak up if you can't hear. All right? Thanks a lot.

DR. LIPSZTEIN: Okay.

DR. NETON: Okay. On the first issue, which is item 2(a), resolve whether sufficient radon data are available, this was the result of the profile not actually addressing or utilizing or summarizing, rather, all of the -- all of the radon data that were available in the CER database.

We've gone back and analyzed those data -- I believe there are around 5,000 radon samples that were taken over -- over the relevant period here. And I've actually provided those -- the -- a document to the stakeholders that shows the results of those summary analyses, providing geometric mean standard deviations and relevant percentiles -- I think 84th and 95th percentiles -- and along with some statistics that demonstrate goodness of fit. As has been the case with almost all these analyses, the data fit a lognormal distribution fairly well. We are proposing to use the distribution of the radon measurements in the facility to assign radon intakes to workers. Now -- so that, for instance, if a person were a worker in the Plant 6, they would be assigned a radon intake equal to the 95th percentile of the radon -- dose radon measurements in that plant by year.

That said, we need to recognize that radon is the largest contributor of dose to the lung. We have done almost all the lung cancer cases in our possession already. And if I'm not mistaken, I think all of those have been -- I'm

not sure -- I'm pretty sure all those have been compensable, and that's driven by maybe factors other than radon, just -- just the -- the uranium intakes. I mean any time you get actinide intakes deposited in the lung, such as you have at Mallinckrodt, the lung doses are going to be very large, and that's been the case here.

So when we propose to provide these 95th percentile distributions, we would apply them to lung cases that -- if necessary, to add to the dose to move them over 50 percent. We don't believe that's necessary in this case. Then we have to get to the relevant issue, which is do we start adding radon tissue doses -- that is what I would call systemic tissue doses -- to -- to the dose reconstructions to account for any dose that may be present due to radon gas or daughters.

DR. MAURO: Jim, it's John Mauro. I have one question regarding the -- the radon database. If I recall in your write-up, within that database you excluded radon measurements associated with when they were cracking the lids, or is that data included in there?

DR. NETON: That data is included. I think that the write-up actually said that we did not exclude it, or something to that effect.

DR. MAURO: Oh, I misunderstood. Thank you.

DR. NETON: Yeah, so in some sense -- you know, we're assuming a chronic exposure to the 95th percentile of -- of the dataset that more than likely includes short term, episodic instances or incidents that could have occurred that were measured, you know, at that time. So you -- and you get some fairly high radon intakes in the -- in the early periods, 1949-'50. After that, it drops fairly well. I thought I had it plotted but I guess I don't have it here.

MS. BLOOM: But you might -- you might have something on a file called "MCW preliminary".

DR. NETON: Well, I don't -- I don't have it on my -- Arjun has it. I have a spreadsheet for radon here, let me just -- I think that's radon breath, yeah. I don't know what that is there. For some reason I don't know what the -- well, anyway, the data --

DR. MAURO: (Off microphone) I think you do.

DR. NETON: -- are summarized -- do I?

DR. MAURO: I think -- I think you do have it

in this document right here (unintelligible).

DR. NETON: What's the document called, John?

DR. MAURO: It's called "Draft Statistical Analysis of Airborne Radon and Coworker Bioassay --

DR. NETON: Right.

DR. MAURO: -- and External Data". One of the tables I believe is the -- by year, the radon measurement data.

DR. NETON: I think this is it right here, hang on. I've worked with so many files in the last ten days I can't keep them straight. And so has my col-- so have my colleagues, all of whom recog-- okay, yeah, here it is.

There's a table, here we go -- yeah, this is a penetrating dose, external shallow, missed dose -- here we go, summary of statis-- of radon in breath, airborne rad-- I'm getting there. Bear with me, please.

Table 7, Summary Statistics of Airborne Radon, Picocuries per liter. You can see in this -- the 50th percentile -- we calculated and measured -- let's just -- they're -- they're very close. That was just to demonstrate the goodness of fit. But we started off with the

50th percentile somewhere in the mid-30 picocuries per liter '48, I'm not sure what happened there in 1949.

I think what's more relevant, actually, if you go over -- we don't have the 95th percentile on here, but if one looks at the -- the 84th percentile, as you get out to the extremes of the distribution the values obviously get higher, and with the GSDs fairly large, particularly 1949. This is where we've had, you know, a massive influx of the K-65 material going through. And I think you can get somewhere upwards of almost 1,000 picocuries per liter at the 95th percentile in '49.

Now that sound-- that is a lot, and the lung dose is going to be huge from that. But -- and we can talk about this in part (b), but if we look at the radon dose to tissues, it's -- at least from the dissolved gas perspective, it's .6 millirem per picocurie per liter of radon gas in the -- in the tissues themselves, so it would -- it would add, at 1,000 picocuries per liter continuous exposure, somewhere around 600 millirem dose. That's not trivial, it's not zero. For the metabolic organs it's very small

compared to what we've calculated. For the non-metabolics it may indeed be worth considering.

That would be the worst case. I think as you go down from there, when you get into the 100 picocurie per liter, 95th percentiles give you a 66 millirem. Now we need to discuss that, whether or not the gas is relevant or the daughters, but -- but we are proposing that we use the 95th percentile of the distribution and then just assign it to workers in the plant. Very similarly to the radon breath analyses, we would take the 50 -- the full distribution and apply it to people who did not appear to have worked full time in Plant 6, those who were ancillary support workers, that sort of thing. So that's where we are. We had hoped to get this more refined than that, but it just becomes difficult to definitively document -- when you start -- when you start parsing the worker job activities too finely, it becomes difficult to -- to demonstrate definitively that you -- you know, you've done that properly. So we are -- we are proposing to use at least these two distributions. There's a

possibility of a third, but we're not there.

MS. BROCK: I have a question that's probably a really stupid question. Maybe I'm just not understanding. When -- I know you say that the lung dose with radon a lot of times is very high, and I -- I think that all the lung cancers so far have been compensable, so I guess I'm confused. When you talk about other tissues, are you referring to organs as well, and is it -- when you use this model, the breath radon model, to dose reconstruct the non-metabolic cancers other than lung or something that wouldn't seem as compensable, are the workers -- are the claimants going to be at a disadvantage using this because of the radon breath model? Would they be better off with the daily weighted average? Could you --

DR. NETON: This is somewhat different -- it's a somewhat different issue than the radon breath. This is -- this is a dose pathway that really was not addressed in the site profile. This is in response to an issue that was raised by SC&A in their review, who indicated that radon gas itself, the progeny, the daughters, are known to cause large doses to the lung and

in general the systemic organs, the doses removed from the lung, the soft tissue. The doses frankly have been ignored in every calculation I've ever seen. They're just assumed to be trivial.

Now for -- but for Mallinckrodt, in -- in cases where you have these very high gas concentrations, it's possible to get doses to the systemic organs that are -- not zero, there's some value. Now we need to make a decision whether we're going to address the doses to those tissues and how we're going to account for those doses. So this is a separate pathway from the radon in breath. It's a -- it's a --

DR. LIPSZTEIN: Hello?

DR. NETON: -- very separate issue.

MS. BROCK: Thank you for clarifying that because it's really confusing for me.

MS. BLOOM: Well, one other thing I would say is that the radon in air has to go with the radon that's going into your lungs and exposing you from going into. The radon in breath has to go from the radon coming out from the radium already deposited in you, so those are two

different exposure --

MS. BROCK: Oh, okay.

MS. BLOOM: -- pathways. In one we use to measure radium and we're not looking at anything to do with the intake of radon separately.

MS. BROCK: Okay. Thank you.

MS. BLOOM: Uh-huh.

MR. GRIFFON: I think I heard Joyce, yeah.

DR. NETON: Joyce, did you have a comment?

DR. LIPSZTEIN: Yes, Jim, I'm talking about now the doses to the (unintelligible) tissues from the radium daughters. What did you -- I tried to get your results that you sent and I couldn't reproduce them. Did you just change the half-life in lung for ten hours for (unintelligible), for example?

DR. NETON: I'll let Dave Allen address that issue because he's the one that did the model.

MR. ALLEN: Hi, Joyce. I did quite a bit with this. I used the lead 214 and determined -- I -- I saw the models and determined the dose per unit intake for .0015 micron particles, and then I did it again for .25 micron particles, both assuming a 10-hour absorption half-life in

the lungs for the lead.

DR. LIPSZTEIN: Right.

MR. ALLEN: Also I assumed a 13-hour absorption half-life for the bismuth 214 that in-grew in the lungs.

DR. LIPSZTEIN: Uh-huh, yes, I saw that. Yeah.

MR. ALLEN: Okay. And I also had the bismuth 214 behaving as its own biokinetic model rather than assuming it behaved as the parent. And then I had to apply an attached fraction to decide how much was .0015 micron versus .25 micron, and also applied the equilibrium factors that are in the paper there.

DR. LIPSZTEIN: I -- I didn't worry too much about the -- the smallest particle size because you (unintelligible) fraction and it's only ten percent of the other one because I think the 10-hour half-life is only applies to the attached fraction. But it doesn't matter because it's so small, the -- the fraction due to it, so the most important would be the .25 (unintelligible) that you calculated. But I couldn't reproduce this. I -- I tried to and my numbers don't get to the same ones that you do and I don't know what -- how -- let's say --

just (unintelligible) the lead 214. Did you do something else besides changing the (unintelligible) the absorption parameters from the respiratory tract from ten minutes to ten hours?

MR. ALLEN: Joyce, I only caught about half of what you said there, but I mean obviously you -- you're saying you didn't -- you couldn't reproduce the same numbers I got. Could you tell me if you were at least in the same ball park as the numbers I got?

DR. LIPSZTEIN: Yes, but for -- it's the same order of magnitude, but what shocked me is the -- the dose to the bone surface because I got a dose that was half of the one in the kidney and you practically got nothing at the bone surface.

MR. ALLEN: If -- if it's --

DR. NETON: Okay.

MR. ALLEN: -- all right with the members of the Board here, this -- this is getting kind of difficult. If -- you know, Joyce is saying that the numbers are in the same ball park, maybe this is one of those situations where we could call off-line and have a conversation.

DR. NETON: Yeah, I think --
DR. LIPSZTEIN: Okay. Okay.
DR. NETON: Yeah, we -- we could work with that.
DR. LIPSZTEIN: Yeah, okay.
DR. MAKHIJANI: Let me try to -- since we have talked about this, at least, let me see if we're formulating the issue right that is to be resolved. When -- when we talked about it in preparation for this meeting, Joyce pointed out that the unat-- there's a small fraction of the radon daughters, the lead and the bismuth, that are mobilized rapidly and you need to take that into account so that the 10-hour and 13-hour half-life doesn't apply uniformly because for the very small particles there's a few percent, according to ICRP-65 Annex B that says that's mobilized rapidly, but it doesn't say how much. Did I get that right, Joyce?
DR. LIPSZTEIN: Yes. Yeah, uh-huh.
DR. MAURO: This is John Mauro, I -- I'd like to just step back a little bit from this for my own benefit so I could come to grips with this issue, recognizing it's a new issue. We, SC&A, did include in one of our reports -- in fact, I

think it had to do with the Y-12 report where it started. I'm not quite sure when we first put this in. I'm not --

DR. LIPSZTEIN: I can't hear you, John.

DR. MAURO: It might have been this one, but --

UNIDENTIFIED: (Off microphone) (Unintelligible) cannot hear you.

DR. MAURO: Let me -- let me explain what my perspective is. We did a calculation using an ICRP model that presented doses to organs other than the lung so -- per picocurie per liter. Okay? That was incorrect. First let me get this on the record. We agree with -- with NIOSH that there are other -- there are other ICRP models -- documents that recommend against doing that and we -- we have since learned that and we agree.

However, we've had lots of conversations regarding this matter subsequent to that, and the nature of those conversations led us to the point where though there are -- there is currently no accepted ICRP model for deriving the doses to organs other than the lung or the respiratory tract, those doses are still not insignificant. And the actual numbers that we

had in our report, which -- which we derived using these ICRP models that we shouldn't have used, are probably not that bad -- perhaps high by a factor of two or three, but the doses are -- given that there are other doses, such as the ones we've been talking about, the doses to these other organs are not insignificant.

For example, as I understand it -- and please correct me if I'm wrong -- when dealing with 1,000 picocurie per liter of radon in the air, assuming 50 percent equilibrium with progeny, the doses to these other organs could be on the order of a rem per year when you consider both the diffused radon into soft tissue together with these short-lived progeny, the portion of which might actually make it to these organs. Correct me if I'm wrong or if I -- am I off by an order of magnitude or am I in the right ball park, more or less? And if I am, is a rem per year to these organs something that is not insubstantial (sic), that's some thing that might be important if there are not other contributors? In my mind, if I'm correct with the one rem per year on that order, it's something that we just can't put aside.

DR. NETON: Well, I -- I think I indicated about five minutes ago that we believe it's probably about 600 millirem per year, just based on the gas distribution alone. And I'm puzzled -- I don't know that your numbers agree with our numbers within a factor of two. I think there's substantial disagreement in your calculations versus ours from the gas model. But with that said, the relevant issue is do we include it. I find it difficult to imagine scenarios where a worker receives 1,000 picocurie per liter radon intakes and does not -- is not going to have ten to the sixth, ten to the seventh picocurie per liter -- or per day per year radium intakes and -- and other associated -- so I -- I think, though, it's relevant, and for completeness purposes I would be hard pressed to argue against adding the dose.

MR. ALLEN: I will.

DR. NETON: Dave -- Dave Allen may. But I think just from a transparency perspective and to indicate its relevance, I don't know how we could not.

MR. ALLEN: This -- this is Dave Allen again,

and as Jim pointed out this morning I think, he's actually measured and I think a number of people have measured that the gas -- radon gas in the body dissolved in the tissues is eliminated from the body with about a 24-hour half-life. If somebody is breathing 1,000 picocurie per liter air, then there's going to be a substantial amount of radon gas in there, yes, but it's going to be coming out in their breath for days. And our approach right here is if this is occurring every day like you would give them credit for if you assumed 1,000 picocuries per liter, then there should be a substantial radon breath measurement that we're assuming is radon -- or radium, I mean, which is going to be substantially higher for any organ than the radon gas is going to be. So by not subtracting the background radon that these people have been breathing, we're already overestimating this by a great deal.

DR. MAURO: I would say that's a very good point and thank you.

DR. NETON: Very good point, Dave. I'm -- I'm glad you're here.

MR. GRIFFON: But that of -- that of course

assu-- I mean the radon issues would be in the same areas as the radium monitored workers, is that -- that's an assumption there, I think, that you have radon breath data for those people that would be in the areas where these radon exposures are of concern?

DR. NETON: Well, that --

MR. ALLEN: That's somewhat of an assumption, yes, but I mean if we're going to allow credit for somebody breathing 1,000 picocuries per liter all year, then some of those got breath analysis and the coworker would have -- you know, same story with the coworker data.

DR. NETON: I think Dave raises a good point. I mean if you -- you know, I think it's the -- the -- the Oswalt* solubility constant, not to get too technical here, is about 1,000th for radon partitioning between the atmosphere and soft tissues, so you would end up with an equilibrium concentration of about a picocurie per liter in your body and ventilating that. And with a 24-hour half-life, you would easily end up with about two-tenths to maybe three-tenths of a picocurie per liter of radon gas in your breath on Monday morning when you showed

up for your radium -- radium analysis. So that's a very good point that that -- you know, by assigning the 95th percentile to these workers, it does end up bounding the -- bounding the whole -- the whole picture. I think that's a -- that's a very interesting approach.

Okay, that was good. All right. And then that -- that gets us away from having to model things that have never been modeled before because, you know, I'm very reluctant to start modeling things outside the ICRP's recommendations.

MR. GRIFFON: Arjun has a comment.

DR. MAKHIJANI: Yeah, I mean this is -- this argument is a new argument and it seems reasonable on the face of it. It's an important issue because it goes to trying to model something, as Jim said, that has never been modeled, which is not a happy proposition given that there's no recommended ICRP thing. So this is a very important thing -- I just -- I just am saying this because I think this is an important item that needs to be sorted out very soon because quite a lot could turn on it.

DR. LIPSZTEIN: Arjun, can you repeat again what (unintelligible)?

DR. MAKHIJANI: Yeah, Joyce, I don't know if you picked up what -- did you pick up what Dave said?

DR. LIPSZTEIN: No, no, that's (unintelligible).

DR. MAKHIJANI: Okay, what Dave said is that if you're breathing in hundreds of picocuries or 1,000 picocuries constantly of radon, then some fraction of that remains in the body for quite a long time and it would show up in many of the workers who had radon breath analysis, and so you'd have had very high results in the tens of picocuries per liter maybe, or higher even, of -- of -- of radon in the breath. And that would be attributed as a radium intake -- first of all, they're not seeing that in radon breath, and it would be attributed as radium body burden, so anyway it'd be very conservative.

DR. LIPSZTEIN: But they took the radon breath measurements after Saturday and Sunday.

MR. GRIFFON: Yes.

DR. NETON: That's correct, Joyce, but radon --

radon has about a 24-hour half-life in the body.

DR. LIPSZTEIN: Yeah.

DR. NETON: And so if you come into equilibrium with 1,000 picocuries per liter, you're going to have somewhere about a picocurie per liter in your tissues. And if you -- if you decay that out over the weekend, I still think that you're going to end up having measurable amounts of radon in your breath on Monday morning that would be attributable to radium intake.

DR. LIPSZTEIN: I'm not sure, and I don't know how you can come out of the modeling anyway.

DR. NETON: I'm sorry, I didn't understand what you said.

DR. LIPSZTEIN: I don't know how you can (unintelligible) the modeling anyway because you have -- you have something that is attributed -- attributable to radium and something that could be of the radium itself, so (unintelligible) measures, so you have to go out to modeling (unintelligible) again, and -- and the model is not -- is not going out of ICRP modeling. We are not doing that. The

only thing we are doing is putting another half-life in the lung, that's all.

DR. NETON: Right, but a half-life is based on one publication that -- I don't know.

DR. LIPSZTEIN: Yeah, (unintelligible).

DR. NETON: But do you not agree that the radon breath measurements would bound and be higher than just modeling the radon dose to the tissues?

DR. LIPSZTEIN: I'm sorry, can you repeat --

DR. NETON: If you assume radon breath measurements on Monday had a component of the radon gas that they breathed at the workplace and we would then be conservative in assigning those to radium intakes, not radon intakes.

DR. LIPSZTEIN: Uh-huh. Yeah, but -- but you don't know how much comes from one and how much comes from the other.

DR. NETON: I know, but if we assume that it's all from -- from radium, the doses to the organs are going to be much higher than the doses that are from the radon daughters.

DR. LIPSZTEIN: Right, that's true.

DR. NETON: I think that's the point, that -- you know, per unit intake, you're going to have

-- if you assume a much higher radium burden, you're going to give higher radium doses than if you -- just from the radon, so -- we -- we can work this out I think and --

MR. GRIFFON: I think that we --

DR. LIPSZTEIN: I think (unintelligible) the numbers on (unintelligible).

DR. NETON: We'll have to -- we'll have to develop a -- an approach and a position on this --

MR. GRIFFON: Yeah.

DR. NETON: -- but I think -- I think this is very well worth -- worth fleshing out, and I don't think it would be that difficult to -- to document in fairly short order. I mean at least the approach.

MR. GRIFFON: I think I -- I agree with Arjun that I'd like to see it laid out. It sound --

DR. NETON: Sure.

MR. GRIFFON: -- sounds reasonable. The other question I have is, you know, there might be a -- a cut-off where you're not able to detect it in radon breath, and it might still be fairly significant dose. It might be a couple hundred rem -- millirem --

DR. NETON: Right, but remember we're assuming a minimum of .1 picocuries per liter as a detection limit for -- for radon in breath.
MR. GRIFFON: Right.
DR. NETON: And even if it's less than that, we're going to assume that that's the minimum that a person breath-- is exhaling.
MR. GRIFFON: Oh, okay, yeah.
DR. NETON: See what I'm saying? So --
MR. GRIFFON: So your cut-off's -- yeah.
DR. NETON: -- so that the cut point is going to be above whatever you're saying is in the radon breath to begin with.
MR. ALLEN: Yeah, I think --
MR. GRIFFON: That's right, 'cause you're doing the coworker --
DR. NETON: Yeah, yeah, yeah.
MR. GRIFFON: I was thinking if they had their own data.
MR. ALLEN: I think the simplest approach to demonstrate it would just be to go through these four examples we already have here on the table, and I could simply assume, you know, the coworker radon inhalation and then sub--
DR. NETON: Compa--

MR. ALLEN: -- you know, for those years and then subtract that -- what would be coming out from the radon inhalation from the radon breath analysis, which would lower the radium intake and simply compare doses. And I -- I'm pretty confident what the answer's going to be on that.

DR. NETON: Yeah, I think (unintelligible) some -- yeah -- something of a 30-minute effective half-life versus radium --

MR. ALLEN: Right.

DR. NETON: -- is going to be much (unintelligible). We'll work on that. We'll take that as an assignment.

DR. WADE: Yeah, I mean I think we'll leave here with the understanding that NIOSH and SC&A will have further discussions on this issue prior to SC&A preparing their report.

DR. MAURO: Yeah, I'd like to add that this strategy for resolution appears to be in the right direction. The arguments that I've heard seem to be a way to get by this issue in a -- in a claimant-favorable and scientifically valid approach. I'd like -- certainly we need to see the write-up, but I'm impressed with

this line of -- this strategy as being the solution.

DR. WADE: So I would encourage NIOSH to prepare materials as quickly as you can on this issue, share them with your colleagues prior to their issuing a report.

MR. ALLEN: And who should I work with on this? I'm assuming I'm going to work on this one. Right, Jim?

DR. NETON: That's correct.

DR. WADE: Jim -- Jim as your point of contact to John, and then John can --

MR. GRIFFON: Yeah.

MR. ALLEN: Okay.

MR. GRIFFON: I think we're on to number three, aren't we?

DR. NETON: Yes, number three. Okay, application of correction factors for external doses to organs. It was raised in the profile review that there were certain geometries that -- Hans, are you there?

DR. BEHLING: Yes, I am.

DR. NETON: Okay, I'll try to speak into the microphone.

Tim Taulbee, are you on the phone?

MR. TAULBEE: Yes, I am.

DR. NETON: Okay, good, we've got key players here.

So, you know, it was -- we modeled, as -- as indicated in the draft Technical Information Bulletin we put out, using this Attila software, what the differences might be to the -- the photon -- what the different photon flux ratios might be relative to a lapel badge versus a -- a lower torso organ when people are working with a non-uniform exposure geometry. And I think we had three examples. One was a -- working on a -- on a derby or something of that nature. One was cleaning up a spill, and the other one was -- I forgot what it was now, but it was another close geometry situation -- a tank, right -- a tank -- oh, yeah, a pot, ore pot geometry. And those Attila -- those Attila calculations indicated to us that it is theoretically possible at least for a lapel badge to -- to underestimate a person's dose to a lower torso, and by that I mean the organs in the trunk below the lung, by up to -- well, by half. You'll be off by a factor of two if you use the lapel badge. It could be twice as high

to the lower torso under those modeled geometries. There were some differences, but I think the highest was -- 2.1 is what I recall. So that said -- and I should point out that we did not model the actual dose to the individual organs. The intent of this Attila run was to model the variation in the photon flux relative to the badge. So in other words, we modeled what the response to the badge on a lapel would be if it were worn on the appropriate portion of the thorax, the lower torso. So -- and then that's the number we would use to convert to organ dose. So I don't want there to be any mis-- misconception that we were trying to model organ doses. We're saying the flux ratio is a factor of two difference, therefore the dose to the badge would be a factor of two difference.

So we -- we -- Tim Taulbee and Greg Macievic have written that into a Technical Information Bulletin. We're proposing to use that factor of two to adjust badges -- badge results for certain classes of workers.

In going through the cases that we have to process, it appears to us that about 57 percent

of the workers, of the cases that we have, this correction factor may be applicable. That is workers who were identified as chem-- operators and building trades type folks. It would not be possible for us to determine with any degree of confidence that they weren't exposed to these close-in -- what we call close-in geometries.

There are a remaining class of workers that we believe -- administrative in nature and security guards, those type of folks who were not working with these close-in operations -- that these factors would not be applied.

That's our proposal. It's certainly open for discussion, but I think that summarizes it in a nutshell.

Tim Taulbee, is there anything I've forgotten I need to add into this?

MR. TAULBEE: Nope --

DR. NETON: Okay.

MR. TAULBEE: -- not that I'm aware of, although there could be questions.

DR. NETON: Yeah, sure.

DR. MAURO: Hans and our crew got together and had numerous discussions on this matter. And I

guess we walk away with the concept that yes, your factor of two to account for the particular adjustment that is of concern here does satisfy our concern.

However, Hans Behling has pointed out that there are two other adjustment factors, and perhaps others, that probably need to be brought to the table at this time. One of them goes toward a concern we raised in our task three report -- in fact, a couple of them do -- whereby other adjustment factors might be in order, especially for lower energy photons, that could actually -- and I'm -- I'm giving you sort of like the preview, and I'd like Hans to speak to this -- could have another factor of two to perhaps factor of three effect on the multiplier. And I think that we'd like to sort of air that out today, and I'd like to give Hans an opportunity to -- to -- to discuss this.

DR. NETON: Okay. Before -- before we jump into this -- this discussion, which I think could be quite lengthy, I'd like to suggest that this may fall into that category of is the profile adequate and are we doing a reasonable

job versus can we reconstruct doses for Mallinckrodt workers. In other words, I think we all have an agreement that the badge is the appropriate starting point, and we have a very large percentage of workers that were monitored. How we adjust those doses is -- is, in my mind, a refinement of the dose reconstruction and not an ability to do them with sufficient accuracy. But that's certainly open for discussion. I don't know.

DR. WADE: Well, I think we should hear from Hans. I mean I think you make your point, and John made it earlier, but I think let's get it on the table while we're here and then we can make that judgment.

DR. BEHLING: Am I on?

DR. NETON: Yes.

DR. BEHLING: Okay. During the last Advisory -- full Advisory Board meeting that took place on July 5 through 7, I presented a summary report on our task three assessment, which looked at all of the various procedures that were used in dose reconstruction, including the Implementation Guide 1 that deals specifically with external dosimetry issues. And I made a

couple of points then and said I wasn't going to discuss any of the technical issues because we had at that point in time not really had a discussion with NIOSH and without any potential technical findings, which is the normal protocol. But given the fact that the SEC petition for Mallinckrodt is somewhat imminent and pressing, it was a internal decision on the part of John Mauro and Arjun and myself to perhaps air a couple of issues that may have a significant impact on -- on the impending SEC petition.

And let me just talk about two particular points. First of all, I do agree with the multiplier of two that deals with the geometry that Jim Neton just explained, which essentially does nothing more than make a correction for certain tissues that are much closer to the source term than the lapel badge, mainly tissues such as the male testes, the colon, the rectum, the prostate, et cetera, which would certainly be -- be covered by this multiplier of two that Dr. Neton just finished discussing.

However, there are a couple of issues that go

beyond that, and one of them is the issue of the uncertainty surrounding the response of a film badge or TLD to a radiation field. In the OCAS Implementation Guide 1 we -- we talk about different components of uncertainty and yet in the end restrict ourselves to really only one. And the three components are laboratory uncertainty, radiological uncertainty, and thirdly, environmental uncertainties. And of course the laboratory uncertainty deals specifically with the processing of the individual badge in terms of film development, the time of exposure, the temperature of the bath and so forth and (unintelligible) to find an uncertainty for that. On the other hand, the implementation guide does provide a very, very difficult process by which this uncertainty needs to be calculated, and we've already mentioned that to NIOSH.

What is really not included in the uncertainty in numerical terms is the second component, namely the radiological uncertainty, and that incorporates, among other things, angle of dependence. In other words, when we calibrate a film badge or a TLD, we usually have a single

point source that's mono-energetic, such as cobalt or cesium, and then the badge in question is pointing at the source term at a zero degree angle. In other words, the face of the badge points directly at the beam, and that gives you the maximum response on the part of a film or TLD.

Once you rotate the film or TLD on its own axis in any form that deviates from zero degree angle, there is a significant reduction. And I pointed that out in our task three report. And so for instance, when you look at a photon energy of about 110 keV -- and I'm quoting this directly out of a textbook, (unintelligible) -- the -- at 90 degree angle, a -- a film dosimeter would only respond to about 16 percent of what it would respond to in terms of a zero degree position. And so angle dependence is a very critical element that has to be looked at, especially for very low energy photons. The angle of dependence does diminish with increased photons and at one MeV can be somewhat ignored. But for very low energy photons, angle of dependence is a very, very critical issue.

Also the issue of back-scatter. It's uncertain from looking at some of the procedures whether or not the back-scatter is incorporated into the dose calculations, including the DCF. In my task three report I identified the variability of back-scatter as a function of photon energy, and of course the size of the medium which serves as the back-scattering source. And they can contribute a significant amount of -- of dose that may or may not be currently being taken into consideration.

So on the -- on the issue -- and of -- I guess thirdly I want to mention is another issue that was mentioned in the implementation guide but not necessary (sic) addressed and that is the environmental uncertainty. And on environmental uncertainty are issues that, for instance, look at the response of a dosimeter based on ambient temperature, especially in a very hot and humid environment where moisture can potentially introduce a certain level of uncertainty, as well as temperature.

So those are the three major components, and in combination they will significantly exceed, I believe, the uncertainties that's currently

being assigned to both film and TLD under the guidance contained in the Implementation Guide 1.

Having said that, let me move on to the second and perhaps more important issue that is also something that I identified in the task three report, and that is I looked at the dose conversion factors and I've come to the conclusion that there is a systemic problem here that affects the accuracy of dose conversion values. I have looked over the implementation guide and fully concur with the methodology that was used in arriving at these DCFs, but also concluded that the methodology is inappropriate for the use in dose reconstruction when the starting point is actually a -- an empirical measurement that's registered on a film or a TLD.

And in preparation for this particular discussion, I had asked Arjun to perhaps -- or John -- to distribute to you one of the pages from the Implementation Guide Appendix B that identifies those conversion values. And the one that I think exemplifies the issue most is the dose conversion value for the female

breast, and I will briefly first ask if the Board members have been given a copy of that particular page.

DR. MAURO: Hans, this is John. I have to apologize, I did not hand it out. I do have it in my hand. What -- what page number was that in OCAS-1?

DR. BEHLING: It's on page 67.

DR. MAURO: Okay, I have -- I'm holding it in my hand now. Perhaps we could have a copy made and -- and pass it around, if that's not a problem. I -- Hans, I'm going to be getting a copy of it. It looks like it should be ready in a minute or two.

DR. BEHLING: Okay, I might want to just already start --

MR. GRIFFON: Wait --

DR. BEHLING: -- the conversation because --

MR. GRIFFON: You know what, Hans --

DR. BEHLING: -- (unintelligible) --

MR. GRIFFON: Hans, can I interrupt? This is Mark Griffon.

DR. BEHLING: -- to a lengthy discussion, but let me (unintelligible) --

MR. GRIFFON: It's hard to interrupt Hans.

DR. BEHLING: -- by pointing out (unintelligible) I've elected to use the female breast as the sample that best exemplifies the concern I have regarding the DCF for the following reasons.

It turns out that the female breast is anatomically at the location most people would be wearing either the film or TLD, and so therefore we can eliminate one of the issues about location because they turned out to be coincidental in terms of location for -- for moni-- personnel monitoring. And so let me go through and identify --

MR. GRIFFON: Hans, can I interrupt a second?

DR. BEHLING: Yes.

MR. GRIFFON: This is Mark Griffon. We're -- we're just going to -- we're getting a copy, and it's a good time for us to take a break.

DR. BEHLING: Okay.

MR. GRIFFON: So would you mind if we can get the copy and then we'll address this on the other side of the break. Also I -- I want to keep in mind -- I think, my opinion at least, is that this is a -- an issue -- a program-wide issue. I don't know that it -- it reflects on

this discussion that we're having about Mallinckrodt. I think it could affect many sites if it af-- you know --

DR. BEHLING: Yes, (unintelligible) --

MR. GRIFFON: -- if we -- if we go that route.

DR. BEHLING: -- (unintelligible) --

MR. GRIFFON: But we'll hear -- on the other side of the break you can lay out the issue, at least, and then we'll move on from there I think.

DR. BEHLING: Okay.

MR. GRIFFON: Is that okay? Okay. Let's break.

(Whereupon, a recess was taken.)

C E R T I F I C A T E OF COURT REPORTER

STATE OF GEORGIA

COUNTY OF FULTON

I, Steven Ray Green, Certified Merit Court Reporter, do hereby certify that I transcribed the above and foregoing from the day of Aug. 4, 2005; and it is a true and accurate transcript of the testimony captioned herein.

I further certify that I am neither kin nor counsel to any of the parties herein, nor have any interest in the cause named herein.

WITNESS my hand and official seal this the 23rd day of August, 2005.

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STEVEN RAY GREEN, CCR

CERTIFIED MERIT COURT REPORTER

CERTIFICATE NUMBER: A-2102