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EVIDENTIARY HEARING

Docket No.: 30-31373-CivP

Location: Chicago, Illinois

Date: Friday, September 18, 1998

Pages: 1053 - 1230

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1 UNITED STATES OF AMERICA

2 NUCLEAR REGULATORY COMMISSION

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4 In the matter of: :

5 CONAM INSPECTION, INC., : Docket No. 30-31373-

6 CivP

7 Itasca, Illinois :

8 - - - - -X

9
10 Federal Building

11 536 South Clark Street, Room LLA

12 Chicago, Illinois

13
14 Friday, September 18, 199815
16
17 The above-entitled matter came on for
18 evidentiary hearing, pursuant to notice, at 9:00 a.m.19
20 BEFORE:21
22 CHARLES BECHHOEFER, Chairman

23 RICHARD F. COLE, Administrative Judge

24 CHARLES N. KELBER, Administrative Judge

25
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C O N T E N T S

WITNESS	DIRECT	CROSS	REDIRECT	RECROSS
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CAROL BERGER

By Mr. Brooks 1061

By Mr. Dambly 1157

By Mr. Brooks 1218

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E X H I B I T S

NUMBER	IDENTIFIED	RECEIVED
Joint Exhibit 26		1062
Joint Exhibit 29		1060
Joint Exhibit 41		1060

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P R O C E E D I N G S

[9:03 A.M.]

CHAIRMAN BECHHOEFER: Good Morning ladies and gentlemen. Before we resume with testimony, Ms. Berger, anyone have any preliminary matters to raise?

MR. BROOKS: Yes, I do, Your Honor. I think it was pointed out to me that I used, with Steven Fay, Exhibit 29 and I had him identify it, but I did not move its submission and I would do so at this time.

MR. DAMBLY: Exhibit 29? We'd object to Exhibit 29 which are excerpts from Mr. Chastain's deposition unless the whole deposition is put in. We have no objection to putting the whole deposition in, but just taking pieces of it, I have an objection to.

MR. BROOKS: This is --

MR. DAMBLY: We'd be glad to supply you with the whole deposition.

MR. BROOKS: This exhibit is being offered not as we would say it, the lawyers would say, for the truth of the matter as asserted in here. It is being offered in this form because it's what Steve Fay was given as his instructions and so if we admit the whole deposition, then we don't have a record of what Steve Fay was given as his instructions.

I'm not offering this to try to tell you what Mr.

1 Chastain said or did, I'm only offering it to tell you what
2 I told Steve Fay to do.

3 MR. DAMBLY: I believe Mr. Fay's testimony was,
4 now I may have misunderstood it, I guess we have it here,
5 but I thought he saw the whole deposition.

6 MR. BROOKS: No, I asked him if these pages were
7 the pages that he looked at as his instructions and he said
8 yes, these are the pages that he looked at.

9 MR. DAMBLY: I don't believe it's proper to admit
10 part of a document.

11 MR. BROOKS: Gentlemen, --

12 CHAIRMAN BECHHOEFER: Well, we thought we would
13 accept into evidence those pages, but if the staff and with
14 the caveat that they will be used for the purpose you
15 described, as instructions, and if the staff wishes to
16 offer the entire deposition, we will also be prepared to
17 put that into evidence.

18 MR. DAMBLY: Well, we would --

19 CHAIRMAN BECHHOEFER: If you think it's
20 necessary?

21 MR. DAMBLY: I do, Your Honor. I think it may
22 well put into context the instructions.

23 CHAIRMAN BECHHOEFER: Right, and so we would --

24 MR. DAMBLY: For all I know, there are other
25 places in the deposition where what he did was described.

1 So, I mean this is some subset of a lot of documents.

2 CHAIRMAN BECHHOEFER: Right, well we will accept
3 the whole entire deposition as some exhibit, you could put
4 a number on it later.

5 MR. DAMBLY: I guess my suggestion, and maybe
6 this is where Mr. Brooks is, why don't we put the whole one
7 in as Exhibit 29. You have on your exhibit list the pages
8 that are contained in there?

9 MR. BROOKS: No.

10 MR. DAMBLY: Oh, you don't?

11 MR. BROOKS: No. This is what he saw and what I
12 was going to suggest, exactly what Judge Bechhoefer was
13 saying. If you want to submit the whole deposition, that's
14 fine with me

15 JUDGE COLE: And give it another number.

16 CHAIRMAN BECHHOEFER: Yeah, give it another
17 number and the whole thing will then be washed.

18 MR. DAMBLY: Well, with that understanding, I
19 would certainly then, at this point, I will provide it to
20 you when we get back and I can make copies, but offer, I
21 guess, as, we are up to Exhibit 40.

22 MR. BROOKS: Forty-one.

23 CHAIRMAN BECHHOEFER: Pardon?

24 JUDGE COLE: We have a 40, I believe.

25 MR. DAMBLY: I guess I see a 40 back here. I

1 have nothing behind it. What was 40?

2 JUDGE COLE: Forty is a letter ballot.

3 MR. BROOKS: From Dr. Cool.

4 JUDGE COLE: Criteria for performing multiple
5 dosimetry.

6 MR. DAMBLY: Oh, okay. I'm sorry.

7 CHAIRMAN BECHHOEFER: So, Exhibit 41 and which
8 you may supply to those who haven't got it. That includes
9 us.

10 MR. DAMBLY: We'll supply, I guess, two copies to
11 the court reporter, or three copies, and one to each board
12 member?

13 CHAIRMAN BECHHOEFER: Right.

14 MR. DAMBLY: Next week.

15 CHAIRMAN BECHHOEFER: I assume you have a copy.

16 MR. BROOKS: Absolutely. That's no problem at
17 all.

18 CHAIRMAN BECHHOEFER: Okay. Well, we will accept
19 into evidence both Exhibit 29 and Exhibit 41.

20 [Exhibit No. 29 was received into
21 evidence.]

22 [Exhibit No. 41 was marked for
23 identification and received into
24 evidence.]

25 MR. BROOKS: Fine, I think we are probably going

1 to take a half an hour or so of Ms. Berger's testimony to
2 lead up to the point where then, I think, she will attempt
3 to answer the Board's questions as part of her homework
4 assignment.

5 JUDGE KELBER: Thank you.

6 CAROL BERGER,
7 a witness having been previously duly sworn, resumed the
8 stand and testified as follows:

9 DIRECT EXAMINATION (Continued)

10 BY MR. BROOKS:

11 Q Ms. Berger, you understand you are still under
12 oath?

13 A Yes, I do.

14 Q Okay. Your homework assignments last night had
15 as a starting point ICRP 26. Are you familiar with that
16 document?

17 A Yes, I am.

18 Q Could you turn to Exhibit 26 in your book?
19 Is that ICRP 26?

20 A Yes, it is.

21 Q What is the ICRP?

22 A The ICRP is a international consensus body that,
23 among other things, makes recommendations on safe use of
24 radiation and radioactive materials while still permitting
25 their beneficial use.

1 MR. BROOKS: I move the admission of ICRP 26,
2 Exhibit 26, at this point.

3 MR. DAMBLY: No objection.

4 CHAIRMAN BECHHOEFER: Without objection, Exhibit
5 26 will be admitted.

6 [Exhibit 26 was marked for
7 identification and received into
8 evidence.]

9 MR. DAMBLY: As Mr. Brooks pointed out, it was,
10 I'm sure a stroke of genius, or just blind luck, that 26 is
11 26.

12 JUDGE KELBER: With this many exhibits, one of
13 them has to balance.

14 BY MR. BROOKS:

15 Q And when was ICRP 26 issued or published?

16 A I believe it was 1977, yes. January 17th, 1977.

17 Q What is contained in ICRP 26?

18 A Basically ICRP 26 was a fairly revolutionary
19 methodology for dose limitation. There's actually three
20 parts to it.

21 They said in that document that no actions with
22 radiation producing machines and radioactive materials
23 would be taken on unless there was some positive benefits,
24 a net positive benefit.

25 Second, they said that all radiation exposure

1 should be kept as low as reasonably achievable.

2 And then third, they said that radiation
3 exposures of the general public and workers should be kept
4 below limits that were prescribed by the Commission, the
5 ICRP.

6 And the approach they used was quite different
7 from the approach that was in place prior to that time.

8 Q We've got a lot of noise, so try to keep your
9 voice up as much as you can.

10 Now you said it set forth a system of dose
11 limitation. Was the system of dose limitation in ICRP
12 different than what had come before?

13 A Yes, it was. In the ICRP a basic assumption is
14 made that the risk of radiating individual tissues should
15 add up to the same risk as radiating the total body in its
16 entirety.

17 JUDGE KELBER: Could you repeat that slowly?

18 THE WITNESS: I probably should use the words of
19 the ICRP, which are better than mine, but I'll try it
20 again.

21 What the ICRP said in document, in Publication
22 26, is that the risk of irradiating individual tissues
23 should be equivalent to the risk of irradiating the total
24 body. By risk, I mean risk to that individual for
25 stochastic effects.

1 JUDGE KELBER: Thank you.

2 CHAIRMAN BECHHOEFER: So you're, interpreting for
3 a layman, saying that the radiation received by a portion
4 of the body, the stochastic effects that could be produced
5 are the same as if the whole body had received the same
6 dose?

7 THE WITNESS: No, I don't think that's it. Maybe
8 the best thing to do is to quote the ICRP. The ICRP says
9 it very eloquently. Let me find the spot.

10 CHAIRMAN BECHHOEFER: I'm just trying to
11 understand.

12 THE WITNESS: The basic assumption is that in
13 order to limit the potential harmful effects of radiation
14 exposure they tried to equate the effects of irradiating
15 the entire body, top to bottom, to the effects of
16 irradiating individual organs. And that was a deviation
17 from the recommendations that they had promulgated back in
18 the 1950's. I believe the words that they used, "The
19 Commission's recommendations are intended to," excuse me,
20 let me jump down.

21 MR. BROOKS: What page are you on here?

22 THE WITNESS: I'm on Page 21, Paragraph 104.

23 It states there that, "For stochastic effects,
24 the Commission's recommended dose limitation is based on
25 the principal that the risks should be equal whether the

1 whole body is irradiated uniformly or whether there is non-
2 uniform radiation." That's the fundamental principle
3 behind this methodology of dose limitation.

4 BY MR. BROOKS:

5 Q And how, just in summary, does ICRP 26 recommend
6 that one be able to compare or equate the dose for a
7 particular part of the body with a dose to the whole body?

8 A They give you an equation. It's very easy, it's
9 very simple, it's still on Page 21, Paragraph 104.

10 They basically say that you take the radiation
11 dose to an organ or tissue of interest and multiply it by a
12 weighting factor. That weighting factor is nothing more
13 than the ratio of the risk associated with radiating that
14 organ individually at the risk of irradiating the whole
15 body to radiation. By risk, I mean risk stochastic
16 effects.

17 There are actually two dose limits in ICRP 26.
18 There is one for non-stochastic effects and one for
19 stochastic effects. And, in this case, I was referring to
20 a dose limit for stochastic effects.

21 Q When we are talking about the risk of stochastic
22 effects, what does that mean?

23 A To put it bluntly, risks of effects that are not,
24 that their magnitude is not proportional to the magnitude
25 of the radiation exposure.

1 Basically, the probability of the effect
2 occurring is proportional to the radiation exposure.

3 Cancer is a good example of that where a non-
4 stochastic effect is the alternative. It's an effect that
5 the magnitude of the effect is proportional to the
6 magnitude of the exposure. Cataracts, certain skin
7 lesions, certain bone, I don't know all of the medical
8 terms, but those are non-stochastic effects that the more
9 you irradiate it, the more amplified the effect becomes.

10 Q Is it fair to say that the dose limitations are
11 related to the risk of health effects from radiation?

12 A That the ICRP's dose limits?

13 Q Yes.

14 A Yes, they're directly related to them. The ICRP
15 set their recommended limit on doses to be one that they
16 felt was appropriate in light of the known relationship
17 between risk and radiation exposure in risk or effects.

18 Q Now in ICRP 26, was there a dose limitation
19 recommended for the annual dose to occupational workers?

20 A There is two dose limits recommended.

21 One is an annual dose limit to specific organs.
22 And the purpose for that dose limit is to prevent the
23 occurrence of non-stochastic effects.

24 And the second limit is an annual dose limit to
25 the whole body when it's irradiated uniformly. And the

1 purpose for that dose limit is to keep the probability of
2 stochastic effects to a practical minimum.

3 Q Now the annual dose limit to the whole body when
4 radiated uniformly, what was the dose limit recommended by
5 ICRP 26?

6 A That's 5 REM per year.

7 Q The same dose limitation that we are dealing with
8 in this case?

9 A Yes, 5 REM per year effective dose equivalent,
10 though. It's for a radiation of the entire body.

11 Q And I don't mean to be repetitive, but when you
12 use the term "annual dose to the whole body when radiated
13 uniformly," what does that mean?

14 Let me strike that.

15 A That means --

16 Q Let me ask you a different question. Why is it
17 expressed in terms of a uniform, full body exposure?

18 A That is because when the ICRP determined what was
19 an acceptable level of risk associated with occupational
20 exposure to radiation, they based it upon the effects
21 associated with radiation of the whole body, penetrating
22 irradiation of the whole body.

23 Q Now, I would --

24 MR. DAMBLY: Excuse me, I would like to just
25 impose a standing objection, just so it's clear, that we

1 believe any discussion of whatever the ICRP did to be
2 irrelevant since we are bound by the NRC regulations and
3 they did not adopt this. I'll just take a standing
4 objection.

5 CHAIRMAN BECHHOEFER: The Board understands that
6 you will have a standing objection. We are going to
7 overrule the objection at least in terms of the questions
8 that are asked now. We understand you do have a standing
9 objection so you will not have to repeat that.

10 MR. DAMBLY: No problem.

11 BY MR. BROOKS:

12 Q Ms. Berger, you were just talking about the
13 concept of uniform whole body exposure and these poor
14 people have heard me talk all week about a hypothetical
15 where my body is covered with a thousand dosimeters. Have
16 you heard me say that?

17 A I caught a little bit of that.

18 Q Okay.

19 A I had a thousand points of light picture in my
20 mind.

21 Q Is the concept of uniform whole body exposure the
22 same thing as my body being covered with a thousand
23 dosimeters and each one of them reading the exactly the
24 same level of radiation?

25 A That's correct.

1 Q Okay. And if I had a thousand dosimeters on my
2 body and they read different readings, some zero, some
3 thirty-four, is that a uniform whole body exposure?

4 A No, it's not.

5 Q Now, you would call that a non-uniform
6 irradiation?

7 A Yes, that's a good term.

8 Q Okay. Does ICRP 26 address, and I think you've
9 already covered a little bit, how to assess the dose in the
10 event of non-uniform dose?

11 A Yes. You determine the dose to the individual
12 organs and then you simply multiply them by the organ
13 weighting factor that's provided in ICRP 26.

14 Q And the purpose for multiplying the individual
15 doses is so that you can compare the result to the standard
16 expressed in whole body uniform exposure?

17 A Right. That's the ICRP's way of letting you
18 compare apples to oranges. You can convert an orange into
19 an apple equivalent orange, so to speak.

20 Q If you were to just take the dose to a particular
21 part of a body and then try to compare that to the standard
22 expressed in uniform whole body exposure, does that work?

23 A You cannot make the comparison directly. You
24 must modify the dose to the particular organs so that you
25 can compare it to a uniform whole body exposure.

1 Q If you were to try to take the dose to a
2 particular part of the body and compare it to a standard,
3 what would you be doing? To a standard expressed in
4 uniform whole body exposure?

5 A If that standard was intended to reflect risk
6 associated with radiation exposure, and if you used that
7 individual organ dose as a reflection of the whole body
8 radiation exposure, you would be inflating or overstating
9 the risk to that individual.

10 Q Are the rating factors that you referred to in
11 Paragraph 104 of ICRP 26 applicable to only internal doses?

12 A No, they're not. They are applicable simply to
13 irradiation of those organs. The ICRP doesn't distinguish
14 between whether the source of radiation is on top of the
15 organ or in front of the organ or behind the organ or
16 inside the organ. It's simply energy deposited per unit
17 mass. It doesn't matter where that energy comes from?

18 JUDGE KELBER: Can I interject one question just
19 for clarification?

20 Does this apply to ingestion of radionucleosides?

21 THE WITNESS: Absolutely. These weighting
22 factors apply to ingestion of radionucleosides because that
23 actually presents two exposure scenarios.

24 Let me use inhalation, because I get two organs
25 closer together. If I inhale an radioncleoside that

1 resides in the lung, I am delivering a dose to the mass of
2 that lung from the radioactivity that is in the lung. But
3 the lung is surveying as a radiation source that is also
4 irradiation the thyroid or the bone or something else. So,
5 I've got both internal and external exposure conditions.
6 So, it was for that reason that the ICRP gave weighting
7 factors that simply pertain to energy deposited per unit
8 mass regardless of where the dose is coming from or the
9 duration over which it is being delivered.

10 JUDGE KELBER: Thank you. Since having worked in
11 a hot particle operation I've always been interested in
12 that problem.

13 BY MR. BROOKS:

14 Q Ms. Berger, why is it that these various tissues
15 identified in ICRP 26 can stand as the measurement or the
16 measuring places of the risk from both internal and
17 external sources of radiation?

18 A Is that the same question that you asked me or
19 did it misunderstand?

20 Q Well, maybe I asked it badly.

21 It is fair to say that these tissues are
22 specified because that's where the risk comes from in
23 radiation?

24 A I see what you are saying. Yes, the ICRP in the
25 1977 recommendations, determined that these organs are at

1 risk of stochastic effects when the whole body is
2 irradiated. There are other organs in the body that aren't
3 called out here. Some are lumped into this big section
4 called remainder. But, they felt that things like the
5 gonads, the breast, the red bone marrow, the lung, the
6 thyroid and the bone surfaces were of particular interest,
7 where at particular risk when the whole body is irradiated.
8 They fine tune that in subsequent recommendations from the
9 ICRP.

10 Q Mr. Dambly just made an objection a minute ago
11 saying, hey ICRP didn't result in our 10CFR Part 20. Is
12 there a connection between ICRP 26 and what we now have
13 come to know --

14 MR. DAMBLY: I want an objection because that's
15 not, it misstates what I said.

16 MR. BROOKS: I apologize. Let me just ask this
17 question.

18 THE WITNESS: I didn't think that's what he said
19 either.

20 BY MR. BROOKS:

21 Q Is there a connection between ICRP 26, issued in
22 1977, and 10CFR Part 20 that was effective as of 1991?

23 MR. DAMBLY: That, I will object also, since she
24 was not involved in the rule making. From anything that
25 I've heard so far there is no foundation she can testify

1 what the Commission did. Or why.

2 CHAIRMAN BECHHOEFER: We'll overrule the
3 objection. The Commission's proceedings are --

4 MR. BARTH: Can't hear you.

5 CHAIRMAN BECHHOEFER: The Commission's
6 proceedings are public documents, publically available. So
7 that --

8 MR. DAMBLY: Well, if what you are telling me,
9 it's okay for her to say well this is what I read, well
10 that's a matter of public record and we don't need the
11 testimony it's cumulative and irrelevant.

12 CHAIRMAN BECHHOEFER: Well it's what she
13 understands. The relationship --

14 MR. DAMBLY: Her understanding is different.
15 Then she is not testifying as to what the Commission did
16 and then we've got a different question and different
17 problem.

18 MR. BROOKS: She's an expert and I believe she
19 can testify on her understanding of all kinds of things
20 that leads her to conclusions she's going to testify to.

21 MR. DAMBLY: I object to that. She is not an
22 expert on NRC regulations, at least she certainly hasn't
23 been qualified as one so far.

24 JUDGE KELBER: I believe that Dr. Cool testified
25 that the NRC, in preparing the rule, involved itself in

1 comments and conversations and discussions with a wide
2 range of experts --

3 MR. DAMBLY: Yes.

4 JUDGE KELBER: -- outside the NRC.

5 MR. DAMBLY: If she was one of those and would
6 like to lay that groundwork for competence to testify, I
7 won't have an objection.

8 JUDGE KELBER: Now hold on just a minute, sir.
9 Now it is from my principle knowledge, and the person
10 knowledge of a large number of people in this room, that
11 those discussions and those comments were widely
12 disseminated and discussed elsewhere among the Health
13 Physics Societies and other interested organizations
14 including the American Nuclear Society and the American
15 Physicists Society, so they are very wide ranging. I do
16 not think that the Commission can claim that it can keep
17 secret how it arrived at it's mystical deviations in Part
18 20.

19 MR. DAMBLY: I don't recall any objection on my
20 part that anybody is keeping anything secret. My objection
21 is there is no foundation laid yet that this witness has
22 any competence or knowledge about which she can testify.

23 JUDGE KELBER: She's an expert.

24 MR. DAMBLY: Not on NRC regulations.

25 JUDGE KELBER: The experts in this field had

1 better be experts in NRC regulations if they work in this
2 country.

3 All right. Ms. Berger, are you familiar with NRC
4 10CFR Part 20?

5 THE WITNESS: Yes, I am familiar with the use and
6 application and the basis for 10CFR Part 20.

7 JUDGE KELBER: Are you familiar with the
8 procedures and discussions involved, both in it's
9 formulation and in discussions of possible revisions?

10 THE WITNESS: Certainly --

11 MR. DAMBLY: Excuse me. I'm going to object
12 to the Board laying a foundation for witness testimony for
13 the --

14 JUDGE KELBER: All right. Why don't we let Mr.
15 Brooks make up to here and get it over with.

16 MR. DAMBLY: Thank you.

17 JUDGE KELBER: I think, frankly, this is just
18 impeding the discussion.

19 MR. BROOKS: I was really just trying to ask a
20 background question here. The matter at issue, I'll just
21 put it in the record, is in the statements of consideration
22 published by the Nuclear Regulatory Commission as it's
23 final rule, this whole page that deals with the
24 relationship between ICRP 26 and 10CFR Part 20. I don't
25 know that it's a controversial proposition. But, do you

1 want me to continue to lay the foundation then?

2 CHAIRMAN BECHHOEFER: Why don't you --

3 MR. BROOKS: Ms. Berger are you --

4 CHAIRMAN BECHHOEFER: At least ascertain what
5 familiarity Ms. Berger has.

6 BY MR. BROOKS:

7 Q In your work have you become familiar with the
8 procedures and processes that when into the public
9 development of 10CFR Part 20?

10 A Yes.

11 Q Okay. And what does that include?

12 A When the proposed rule -- do you want me to
13 describe it generally?

14 Q Describe what your sources of knowledge and
15 involvement of that process are?

16 A When the proposed rule was issued on behalf of
17 both the organization I was working for and on others, I
18 did a review of that rule and provided comments on behalf
19 of others as a part of the development of that rule and
20 they were submitted to the NRC.

21 JUDGE COLE: When was this, Ms. Berger?

22 THE WITNESS: Pardon me?

23 JUDGE COLE: When was this, 1991?

24 THE WITNESS: This is more than one time. No,
25 this is prior to that time. This dated back into the

1 1980's. I believe the original proposed rule was issued
2 in, what was it '88? I'm not sure of the date, I can't
3 think of it, but I believe it was in the '80's.

4 MR. BROOKS: Is that a sufficient qualification
5 at this point for me to ask her the basic questions that I
6 was asking?

7 JUDGE KELBER: Proceed.

8 MR. BROOKS: Thank you.

9 BY MR. BROOKS:

10 Q Let's back up again. Ms. Berger, is there a
11 connection between the 1977 ICRP 26 and the 10CFR Part 20
12 that became effective in 1991?

13 A Yes, I believe that there is. I don't believe
14 that the NRC created this system of dose limitation. It
15 was drawn from ICRP 26 as it stated in the statements of
16 consideration.

17 The Federal Radiation Protection Guidance
18 acknowledged that the ICRP 26 methodology of dose
19 limitation was revolutionary and was more applicable and to
20 more exposure situations that were more likely to be
21 encountered in industry and were based upon more advanced
22 science. Therefore, the Federal Radiation Protection
23 Guidance asked the federal agencies to incorporate the
24 recommendations of the ICRP into their regulations.

25 Q And you just mentioned something called the

1 Federal Radiation Protection Guidance?

2 A Uh-huh.

3 Q What is that?

4 A Basically, Ronald Regan signed a document that
5 was an, I don't know if I'd call it a directive, it
6 probably was, I guess, a directive, to federal agencies to
7 follow a given approach in protecting workers and members
8 of the public from the potentially harmful effects of
9 radiation while still permitting it's beneficial use. All
10 with that basis is still the same.

11 Q Approximately when did President Regan sign the
12 Federal Radiation Protection Guidance?

13 A I believe that was 1986, but I'm not good at
14 dates, Chip.

15 Q Did the Federal Radiation Protection Guidance
16 include in it the ICRP 26 system of using rating factors?

17 A Oh, absolutely. That was spelling out explicitly
18 that the way to compare or to evaluate non-uniform
19 exposures, exposures to specific organs, was to apply the
20 use of organ weighting factors.

21 Q Is there a relationship then between the Federal
22 Radiation Protection Guidance and 10CFR Part 20?

23 A I suspect that the NRC implemented the Federal
24 Radiation Protection Guidance because it was issued, but
25 I think that maybe indeed getting into discussions that

1 are --

2 Q Objectively speaking, does 10CFR Part 20 embrace
3 the recommendations in the Federal Radiation Protection
4 Guidance?

5 A Globally speaking, it does. The definitions are
6 similar, the fundamental basis for the approach is similar.
7 There, of course, are differences.

8 Q Specifically, with respect to the system of dose
9 limitation identified in ICRP 26 and the Federal Radiation
10 Protection Guidance, is that system of dose limitation
11 adopted in 10CFR Part 20?

12 A Yes, it is. The fundamental system of dose
13 limitation is there.

14 Q Now, does 10CFR Part 20 adopt as part of that
15 system of dose limitation the weighting factor system
16 identified in ICRP 26 and the Federal Radiation Protection
17 Guidance?

18 A Yes, they're identical.

19 Q When you say they're identical, what do you mean?

20 A They are the exact same numbers and the exact
21 same tissues at risk. The list is identical.

22 Q Now, you identified and pointed the Board toward
23 Paragraph 104 of ICRP 26 which contained a set of weighting
24 factors. Are those weighting factors found in 10CFR Part
25 20?

1 A Yes, they are. I don't have a copy of 10CFR Part
2 20 here, I can show you the citation.

3 Q At this point, I suspect we all know where they
4 are.

5 A Okay, it's in Section 20.1004 - Definitions.
6 There is a definition for weighting factor and --

7 Q It might be 1003.

8 A I'm sorry 1003, excuse me. You're right, 1003.
9 And, you have that memorized, don't you. And they give a
10 table of organ dose weighting factors which are identical
11 to those that are in Paragraph 105 of Page 21 of ICRP 26.

12 Q Now, in 10CFR Part 20, does it specify whether
13 those weighting factors apply particularly to internal or
14 external doses?

15 A No, it does not. It does not make that
16 distinction.

17 Q Does 10CFR Part 20 provide a methodology or a way
18 of using those weighting factors to apply to internal
19 weighting doses?

20 A Yes. You simply assess the radiation dose to a
21 specific organ from radiation sources that have been
22 incorporated into the body, whether by inhalation or
23 ingestion, and then multiply it by the weighting factors.

24 Q You're saying the weighting system that came from
25 ICRP 26?

1 A Identical, that's correct.

2 Q Now, with respect to the use of these weighting
3 factors, is there any respect in which 10CFR Part 20
4 departs from the recommendations of ICRP 26?

5 A There's a number of them, but I think that the
6 point at issue here is that it is permissible in 10CFR Part
7 20 to compare radiation dose from non-uniform exposure of
8 the whole body to a uniform exposure dose limit. That is
9 possible in 10CFR Part 20. It is possible to compare
10 apples and oranges in 10CFR Part 20.

11 Q And let me point you specifically to 20.201C.

12 A Yes, that's correct. That's the statement where
13 it says that the assigned deep dose equivalent must be for
14 the highest exposure.

15 Q If you take 1201C and the weighting factor
16 definition is there a part in there that specifies a
17 default weighting factor of one?

18 A Yes, there's a footnote to that that specifies a
19 default weighting factor of one. I interpret that --

20 Q For what does it specify?

21 A That's for the purpose of weighting external
22 whole body dose. I interpret that a little differently. I
23 interpret that to mean that no weighting factors are
24 possible, that you cannot weight the dose from non-uniform
25 exposure if the source is from outside the body as opposed

1 to inside of the body.

2 Q Now, from a methodological standpoint, is there
3 anything wrong with that system?

4 A Well, like Dr. Cool was saying yesterday, it can
5 be hard to write regulations --

6 MR. DAMBLY: Excuse me. I'll object. Whether
7 she thinks there's anything wrong with the NRC system of
8 doing things is totally irrelevant. This is not a rule
9 making. We are under the regulations as they exist, not as
10 somebody wishes they were.

11 MR. BROOKS: We were laying a foundation for why
12 what is permitted in the footnote, and that is the approval
13 of other weighting factors is going to make sense in this
14 case because of the problem with using the weighting factor
15 of one. What we're trying to get to right now is the
16 witnesses testimony as to what the problem is with using
17 the weighting factor of one where you have a non-uniform
18 exposure.

19 MR. DAMBLY: And even with that proffer, I have
20 an objection because I don't care if she had a problem with
21 using one. If the regulations say one, that's what we are
22 dealing with.

23 JUDGE KELBER: I think I better commend it to our
24 presiding officer that it be overruled because Footnote 2
25 to that infamous table explicitly contemplates the possible

1 use of other weighting factors. It would interesting, very
2 interesting, to know what the technical considerations are
3 that are involved in that.

4 MR. DAMBLY: In the footnote?

5 JUDGE KELBER: Footnote 2 to the table in 1003.

6 MR. DAMBLY: I believe the agency experts
7 testified to with the considerations.

8 CHAIRMAN BECHHOEFER: Mr. Brooks, I think you
9 should rephrase your question to not say is anything wrong
10 with the regulations.

11 MR. BROOKS: Fine.

12 CHAIRMAN BECHHOEFER: Mr. Dambly is correct, if
13 there is something wrong with them, you can't do anything
14 about it.

15 MR. BROOKS: Sure.

16 CHAIRMAN BECHHOEFER: But if there is something
17 consistent with it --

18 BY MR. BROOKS:

19 Q What is the effect of using a weighting factor of
20 one with respect to a non-uniform external exposure?

21 A If I can lead up to that answer, under most
22 circumstances when the whole body is irradiated uniformly,
23 which is a common assumption in radiation protection
24 practice, then this statement in here, the use of a
25 weighting factor of one or no weighting of the dose is

1 appropriate. It is technically sound, but on the rare
2 occurrence when the body is not irradiated uniformly, where
3 only maybe one or two or only a portion of the body, or a
4 portion of some organs is being irradiated, then the
5 inability to apply a weighting factor when you calculate
6 the dose to that organ, before you compare that dose to a
7 whole body dose equivalent limit means you will over
8 estimate the dose and, again, you are comparing apples and
9 oranges.

10 Q Does 10CFR Part 20 require that that approach,
11 the weighting factor of one, be used?

12 A I don't believe it does, that's why Footnote 2 is
13 down that there. It's that under circumstances where you
14 need to apply weighting factors that these would be
15 approved on a case-by-case basis.

16 Q Now, I 'd like to take you back to the time
17 during and prior to 1991 when these standards in 10CFR Part
18 20 were promulgated, do you know of any reason why 10CFR
19 Part 20 doesn't specify a methodology for using external
20 dose weighting factors?

21 A I believe I do. There were a lot of people doing
22 external doses from non-uniform fields using and applying
23 the ICRP 26 weighting factors in subtly different ways.
24 The ICRP 26 weighting factors were always used in all
25 cases, but the application of those factors varied quite

1 widely amongst those of us who were doing those kinds of
2 doses.

3 So there was no set -- you couldn't look up in a
4 book for a table, external dose weighting factors and
5 multiply them. They were not available and in some cases,
6 it just stands to reason that it would be wise to approve
7 those on a case-by-case basis just to determine whether
8 they indeed were applicable to those exposure situations.
9 I certainly don't take any exception to that.

10 Q Let me ask you, you mentioned work that you were
11 doing. Between say 1986 and 1991, were you calculating
12 doses based on non-uniform external exposures?

13 A Yes, I was.

14 Q During that time period, how were you doing it?

15 A Not the way the ANSI Standard said. We were
16 doing it not just on a case-by-case basis, but on a person-
17 by-person basis. We were actually measuring the location
18 of where organs were in what compartment of the body. We
19 were actually looking to see how much of a particular organ
20 resided in the area that was being radiated, either through
21 physical measurements or ultrasound.

22 Q And you mentioned in compartments of the body.
23 Does that refer to how you translated the organ dose rating
24 factors founds in ICRP 26 to various parts of the body?

25 A Yes. And again, this deviates somewhat from the

1 ANSI STANDARD too. As we were attempting to determine the
2 dose to organs but the compartment sizes, or the
3 compartments, were not necessarily defined the way they
4 were in the ANSI STANDARD. And the approach that we were
5 using wasn't unique. I mean, there were others doing
6 something similar. There were also other organizations
7 that were taking simple books of anatomy and calipers and
8 measuring how much bone falls in the thorax and how much
9 falls in the stomach and there were other organizations
10 that were using the recommendations of the ICRP in
11 Publication 23 Reference Man. There were a lot of
12 approaches to it at that time.

13 Q You just mentioned Publication 23 and Reference
14 Man? What is Publication 23?

15 A For the purposes of dose limitation it can
16 sometimes be hard, sometimes, it's always hard, to assess
17 and evaluate radiation doses to individuals. You have to
18 make some simplifying assumptions. We have to make some
19 assumptions about the common metabolism of a certain
20 radioactive material in the body or we have to make some
21 assumptions about how much air is breathed in and breathed
22 out. So the ICRP made some recommendations. They were
23 originally called Standard Man. The name was then changed
24 to Reference Man around 1971 or '71, I can't remember. I'm
25 real bad at dates. I apologize. But, basically they just

1 defined a reference quemma that can be used for dosimetric
2 and other purposes.

3 Q Going back to the big picture then, up to the
4 time when 10CFR Part 20 was made effective in May of 1991,
5 were there any consensus industry standards on
6 compartmental or weighting factors that could be used for
7 non-uniform external doses?

8 A Not in the way that I think this group is
9 applying the term consensus standards. There were none
10 from the American National Standards Institute or AFCM or
11 the ICRP or the ICRU or any like that.

12 Q Would you turn to Exhibit 24 in your book?

13 I'm sorry, did you have a question?

14 CHAIRMAN BECHHOEFER: Well, I have one inquiry.

15 MR. BROOKS: Sure.

16 CHAIRMAN BECHHOEFER: I was trying to figure out
17 if now was a good time to do it, but when Dr. Cool
18 testified, I believe it was he, he limited the
19 applicability of the table and the footnote to pre-planned
20 exposure and I'm trying to figure out if that makes any
21 sense in terms, and you may know something from the ICRP
22 background.

23 THE WITNESS: Well, the ICRP offered a method of
24 dose limitation and dose assessment that's independent of
25 whether that dose was delivered in a pre-planned fashion or

1 whether it was an accident that you have to access the dose
2 retroactively. Dose assessment is dose assessment. You
3 still have to apply the weighting factors whether it was a
4 planned dose, if it's non-uniform exposure, or whether it
5 was a radiation dose that occurred as a result of something
6 that was unanticipated. I'm not sure I follow that
7 statement either because dose assessment is dose assessment
8 regardless of whether it's an accident or not.

9 CHAIRMAN BECHHOEFER: Were you here when Dr. Cool
10 made that?

11 THE WITNESS: I heard that, but I didn't
12 specifically hear that. I couldn't hear everything he
13 said. It was a little loud in here.

14 MR. DAMBLY: I don't believe that's what Dr. Cool
15 said. But the record is what the record is so there's no
16 use arguing over it.

17 CHAIRMAN BECHHOEFER: Well this is my
18 recollection. Maybe when I recheck the transcript I'll
19 find out differently. My recollection limited it to things
20 like pre-planned exposure.

21 MR. DAMBLY: I think that was in direct reference
22 to the footnote on approval of case-by-case.

23 CHAIRMAN BECHHOEFER: Yes, well that's what I
24 was --

25 MR. DAMBLY: Not use of weighting factors to

1 internal organs. I don't think he said that was on pre-
2 planned exposure.

3 CHAIRMAN BECHHOEFER: Oh, I'm sorry. I'm sorry.

4 MR. BROOKS: Ms. Berger --

5 CHAIRMAN BECHHOEFER: I didn't mean to have the
6 broad implication, broad statement, that I perhaps did.

7 MR. BROOKS: All set?

8 CHAIRMAN BECHHOEFER: Okay.

9 BY MR. BROOKS:

10 Q Ms. Berger, I've asked you to turn to Exhibit 24
11 in your book.

12 Can you identify that document?

13 A Yes, this is American National Standard No.
14 HPSN13.41-1997 and it's entitled "Criteria for Performing
15 Multiple Dosimetry."

16 Q Did you personally have any role in the
17 development of this document?

18 A Yes, I was a member of the working group that
19 prepared the original draft of the document and then
20 responded to comments and modified the document as it went
21 through the consensus balloting process.

22 I was chairman, chair of the committee beginning
23 in about 1988. I was a committee member when it was formed
24 in 1986.

25 Q What was the purpose of the working group?

1 A The purpose was to address issues much like I
2 said here just earlier. As we had a lot of different
3 organizations doing a lot of different dose calculations,
4 and trying to apply the ICRP 26 weighting factors in
5 certain ways. At the same time we had a lot of different
6 organizations trying to assess radiation doses from non-
7 uniform exposures by using multiple dosimeters, but, again,
8 they were doing them in many and various different ways.
9 So the purpose of this working group was to define a
10 methodology for, number one, determining whether multiple
11 dosimeters were required in certain exposure circumstances
12 and then, if it was determined that multiple dosimeters
13 were required, how do you deploy them, how do you retrieve
14 them, how do you process them, where do you place them?
15 And then, once you've done that, who do you interpret the
16 results from the use of multiple dosimeters to compare it
17 to the effective dose equivalent limit.

18 Q When you are talking about a multiple dosimeters,
19 is a film badge a dosimeter for this purpose?

20 A Yes, this would be not unlike your thousand, this
21 coat of dosimeters, this issue. It's using more than one
22 dosimeter for the purpose of assessing the effective dose
23 equivalent.

24 Q When did your working group come up with the
25 draft set of standards?

1 A There were many drafts. The very first draft was
2 probably in early 1987. But there were many drafts. It
3 went to the Health Physics Society Standards Committee for
4 their review and approval and concurrence, probably in the
5 early 1990's. After they reviewed it, we got back ballots
6 and for every negative ballot, we had to address the issues
7 raised by the dissenting voter or explain why we could not
8 accept those dose recommendations.

9 Q Let me back up for a second.

10 You mentioned the Health Physics Society
11 Standards Committee?

12 A Yes.

13 Q That approved your ultimate draft?

14 A The Health Physics Society Standards Committee
15 approved a draft of the standard.

16 Q Then what happened to that draft?

17 A It then went to ANSI Accredited Committee N-13.

18 Q Now what is the N-13 Committee?

19 A Well that committee is made up of representatives
20 of a variety of organizations, in fact I think they list
21 them --

22 Q You want to turn to Page 6 of Exhibit 24.

23 A Right, Page 6 of Exhibit 24 lists the members
24 that were on N-13 at the time that this standard was
25 balloted.

1 Q Do you see Dr. Cool's name on the list?

2 A Yes, I do.

3 Q What did the N-13 Committee do with the draft
4 proposal that your working group had created?

5 A Somewhat the same thing as the Health Physics
6 Society Standards Committee. They reviewed the proposal,
7 they provided comments and they voted as to whether the
8 proposal, or whether the standards should become an ANSI
9 STANDARD. For all of those votes that were negative, the
10 working group had to either make the changes recommended by
11 the descending voter or provide justification why that
12 change could not be made. And then once that was done, the
13 standard was redrafted to incorporate all of the changes
14 and then re-circulated through the committee for final
15 balloting.

16 Q Was this document ultimately approved by the N-
17 13 Committee?

18 A Yes. Final balloting was completed on, I
19 believe, in June and I think it says that somewhere in
20 here. Yes, also on Page 6 the final balloting, the
21 standard was approved in June of 1996.

22 Q After the N-13 Committee approve it, then what
23 happened?

24 A Then the standard went to ANSI --

25 Q What is ANSI?

1 A American National Standards Institute for
2 preparation as an ANSI Standard. They went through the
3 task of formatting and making sure that it was written
4 consistent with the ANSI criteria for standards. There
5 were some changes to the draft standard that were made
6 then, but they were not substitutive. If there had been
7 any substantive changes between June and final publication
8 it would have had to go back to N-13 for balloting. So
9 there were some typographical errors that were changed and
10 some formatting changes and the standard was finally
11 approved for publication and in it's form that you see here
12 in, I believe, it was very early December of 1996.
13 And then it finally was published and available, I think,
14 in January of '97, thereabouts.

15 Q You said earlier that this standard provides a
16 system for using multiple dosimeters?

17 A That's correct.

18 Q Okay. And that's opposed to using a single
19 dosimeter or single film badge?

20 A Yes, that's correct.

21 Q And under what circumstances would one use
22 multiple dosimeters?

23 A There are two circumstances given in the
24 standard. One when the exposure is high enough to warrant
25 the use of trying to basically fine tune the dose and

1 second when there's a sufficient dose radiant. When it is
2 clear that only a small portion of the body is being
3 irradiated versus the entire body irradiated uniformly.

4 Q And explain again now why in the ANSI 13.41
5 Standard there is a set of compartment factors. You're
6 using compartment factors to be an incorporation of
7 weighting factors, is that right?

8 A Yes, that's correct. Well, the compartment
9 factors are just one part of the standard.

10 Once you make the decision to use multiple
11 dosimeters and once you have data back from the processing
12 of the multiple dosimeters, the standard now gives you a
13 methodology for calculating or determining the effective
14 dose equivalent based upon having dosimeters in many and
15 various places on the body.

16 Q Can you point out to us where in ANSI 13.41 these
17 compartment factors are that you've identified?

18 A Yes. It's on Page 15, Table 1.

19 Q How were these compartment factors created?

20 A The basis for the compartment factors are the
21 organ weighting factors out of ICRP 26. They're absolutely
22 identical.

23 Q And the organ weighting factors in 10CFR Part 20?

24 A Yes, that's correct. They're the same factors.

25 In fact if you look at the definitions in the ANSI STANDARD

1 it gives the definition for weighting factor and they're
2 also identical to their weighting factors in ICRP 26. It's
3 on Page 11 of the standard.

4 But, the approach here, I'd like to say it's new,
5 unique and exciting, but it really wasn't rocket science.
6 The committee just determined how much of an organ or how
7 many organs resided within a body compartment that might be
8 a reasonable breakdown of compartments for external
9 dosimetry purposes.

10 For example, in the thorax, we've got the
11 totality of the lung, the entire lung is in there. We've
12 also got, what else have we got in the thorax, the breast
13 is in the thorax. But, we've only got parts of the bone
14 marrow and the bone surfaces. There's only a little bit of
15 the bone that's in here, the rest of it is down in the
16 abdomen and in the thighs about the knees and the arms
17 above the elbows.

18 So basically, it's just divvying up the organs
19 into the right compartments and assigning that portion of
20 the ICRP 26 weighting factor to that compartment.

21 Q Now I know in your compartment factors here that
22 fifty percent of the weighting is assigned to the abdomen,
23 is that right?

24 A Oh, let me look at the right one. Yes, fifty
25 percent, let me make sure I get this straight. Fifty

1 percent of the organs that are called out in ICRP 26 are
2 included in the definition of abdomen in this case.

3 Q And I note that -- I'm sorry go ahead.

4 A Let me say one more thing.

5 Q Sure.

6 A It may not be all of the organ. For example it's
7 not fifty percent of the bone marrow. In the abdomen, I
8 think, there's the intestines and there's some bone marrow.
9 There may be some liver, I believe, in the abdomen. I'd
10 have to go back and look. It's not all of the organ in
11 there, but fifty percent of all of the organs are included
12 in the abdomen compartment.

13 Q I note that five thousandths of the weighting is
14 assigned to each of the thighs, is that right?

15 A Yes, that's correct.

16 Q Why such a small number?

17 A Well, the thigh above the knee and the arm above
18 the elbow to the shoulder only contain really just the
19 blood forming organ. So there's only a small portion of
20 the bone marrow that appears in those organs, in those
21 compartments.

22 Q And does that, the fact that there's a small part
23 of those organs in the thigh, relate to the risk of
24 stochastic effects from an irradiation of the thigh?

25 A Yes, it's exactly identical to the basic premise

1 of ICRP 26.

2 Q How did you establish these compartments?

3 A The committee chose to go with the ICRP
4 recommendations on Reference Man and ICRP Document 23
5 instead of --

6 JUDGE KELBER: Document which?

7 THE WITNESS: Publication 23, instead of using
8 anatomy books and individual measurements and things.

9 MR. BROOKS: Now as -- I'm sorry.

10 JUDGE COLE: Could I ask a question here?

11 MR. BROOKS: Sure.

12 JUDGE COLE: Looking at Table 1 on Page 15 of
13 Exhibit 24, it's not just coincidental that the sum of the
14 compartment factors is one, is it?

15 THE WITNESS: They all have to add up to one
16 because the goal is to make comparison to uniform
17 irradiation of the body which includes all of the organs.

18 BY JUDGE COLE:

19 Q Okay. So suppose I have a large dose to the
20 lower part of an arm or a leg?

21 A You're talking about the arm below the elbow?

22 Q Right.

23 A There are not real tissues at risk. There's no
24 blood forming organs in the arm below the elbow and
25 therefore, there is a different limit on the radiation

1 dose. The non-stochastic limit becomes the driving limit
2 which is 50 REM. The purpose of this methodology, of using
3 compartment factors, is get you back to the effective dose
4 equivalent for the purpose of limiting stochastic effects
5 as opposed to non-stochastic effects.

6 Q I understand.

7 A And I think it states up-front that the
8 extremities are excluded.

9 Q Thank you. Excuse me, Mr. Brooks.

10 MR. BROOKS: No, no problem. We're here to
11 answer your questions.

12 BY MR. BROOKS:

13 Q How does the methodology that you've just
14 described in ANSI 13.41 as applied to external doses
15 compare to the methodology for computing dose from internal
16 exposures in 10CFR Part 20?

17 A The fundamental basis between the two are
18 identical. They're absolutely identical. They use the
19 exact same organ weighting factors. You assess the
20 radiation dose to an organ, apply the organ weighting
21 factor, add them all up, and you now have the effective
22 dose equivalent to that person. It's absolutely identical.
23 There's no difference between the two.

24 Q Now it has been pointed out previously, I
25 believe, that the ANSI 13.41 Standard has as part of it's

1 scope an application to uses of multiple dosimetry in
2 routine occupational activities. Are you familiar with
3 that?

4 A Yes.

5 Q Why does the scope of this standard have that
6 limitation?

7 A Well, first the ANSI Standards are used by
8 agencies other than those that are regulated by Federal
9 Regulatory Authorities and even by other countries and many
10 organizations like to have what they call an ANSI compliant
11 program. If I want to provide a multiple dosimetry program
12 for my workers and I would like it to be a ANSI compliant
13 program, I need to comply with the totality of the
14 standard. Therefore, the scope, as written here, applies
15 to the totality of the standard. If I use this standard
16 and I make a decision based upon my knowledge of the
17 radiation environment in a particular area to put
18 dosimeters on the thorax and the upper arms, and maybe
19 somebody is working in a glove box and that's where most of
20 the dose is going to be, and if during this process this
21 source their working on flops on to the floor, now I've got
22 that that radiation field has just been lowered. No longer
23 can I use those two dosimeters, the results of those two
24 dosimeters and these compartment factors, disregarding
25 everything else to assess the dose equivalent. The

1 placement of those dosimeters is not appropriate in that
2 case.

3 So when there has been an unexpected change in
4 the dose distribution over the body, the totality of the
5 standard doesn't apply. I am troubled by the attempt to
6 kind of cut out bits and pieces in here because if we say
7 that we have to disregard everything that's in this
8 standard because of that statement and scope, we also have
9 to disregard the use of the ICRP 26 and 10CFR 20 weighting
10 factors as being invalid in the case of an accident because
11 they are used as definition in this standard.

12 Q Let me ask you, let's go to just what you are
13 talking about. Wholly apart from the rest of the 13.41
14 Standard, is there any reason that the compartmental factor
15 methodology in 13.41 is applicable only in the case of
16 routine occupational activities?

17 A Is there a reason why it's only --

18 Q Would it be useful only for routine occupational
19 activity doses?

20 A No, again, it's just like the weighting factors
21 in ICRP 26. It doesn't matter whether the dose occurred by
22 accident or intentionally, you can still apply the ICRP 26
23 factors. There's no difference there.

24 Q Whether it's an accident or whether it's a
25 routine occupational activity, does that impact at all the

1 utility of the compartmental dose computation system?

2 A No. The only thing that impacts that would be
3 impacted, and that's why it's raised in the scope, is your
4 measurement method, do you have the dosimeters in the right
5 place, that sort of thing.

6 Q Let me ask you about dosimetry. Do you need to
7 use multiple dosimeters in order to use the departmental
8 weighting factor system in ANSI 13.41?

9 A No. The compartment weighting factors, the
10 compartment factors that are given are simply a method of
11 translating the individual dosimetry results into an
12 effective dose equivalent. That's the only purpose that
13 they serve.

14 Q Can you use that system, the methodology of the
15 compartmental factors, for calculated doses to various
16 parts of the body?

17 A Oh, absolutely. I'm sorry. I interrupted you.

18 Q That's okay.

19 A If you have a radiation dose to a given
20 compartment, it doesn't matter if you got it by
21 measurement, by survey, by calculation, you can still apply
22 the same compartment factors.

23 JUDGE COLE: So it doesn't make any difference as
24 long as you have a knowledge of what the distribution is?

25 THE WITNESS: Yes. You have to know that the

1 exposure was non-uniform and that the exposure was
2 different in different compartments. If you have no real
3 reason to know that, this standard, in fact the committee
4 was very careful to state that, it does not require the use
5 of multiple dosimeters. Common practice, and it's been
6 this way for many, many years, is that a single dosimeter
7 gives you a valid representation of whole body dose
8 equivalent. The standard was never meant to replace that
9 thinking. It's only in cases where you know that the
10 radiation dose to the individual is going to have a very
11 steep dose rating.

12 JUDGE KELBER: Is the same position roughly on
13 use of dosimeters reflected in the NRC Regulations?

14 THE WITNESS: The use of multiple dosimeters?

15 BY JUDGE KELBER:

16 Q Well, okay, let's put it that way. Are there NRC
17 Regulation which require the use of multiple dosimeters?

18 A No directly. The NRC Regulation doesn't require
19 the use of multiple dosimeters, it only states in, what was
20 it, 1201C that the assigned dose equivalent -- and that's a
21 reason actually, the standard never did say that. There
22 are reasons when you would want to use multiple dosimeters
23 in order to determine what the maximum exposure is to a
24 given compartment. That was another purpose for this
25 standard. The standard envisioned that it would be used by

1 NRC licensees.

2 Q I see. Part 1201C. Could you quote the words?

3 A Yes. It says that the, "The assigned deep dose
4 equivalent and the shallow dose equivalent must be for the
5 part of the body receiving the highest exposure." One way
6 of doing that is to hang dosimeters all over the body.

7 Q I see.

8 A That's only one way.

9 BY MR. BROOKS:

10 Q Under what circumstances would the methodology of
11 using these compartmental weighting factors be appropriate?

12 What do you use that for?

13 A The only time you would use the compartment
14 weighting factors is if there was non-uniform irradiation
15 of the whole body. The only time.

16 Q Is that methodology that you've described in ANSI
17 13.41, the compartmental factor methodology, an industry
18 consensus standard at this point?

19 A By virtue of the fact, yes. That's promulgated
20 by the American National Standards Institute. It is
21 received, not every person in the industry has concurred
22 with it, but representatives of a broad breath of industry
23 as well as technical organizations through the Health
24 Physics Society Standards Committee has concurred that this
25 is a reasonable industry standard.

1 Q As of today, are there any other industry
2 approved standards that have been approved in that same way
3 for compartmental factors?

4 A Not the conventional standards organizations I
5 think we are referring to here. There are some industry
6 approvals that we can't ignore. I think, for example,
7 there's some operations offices of the Department of Energy
8 that in fact have got approved compartment factors,
9 although in that case, I believe, they've adopted these in
10 there strictly.

11 But in the types of standards organizations we're
12 used to referring to, ICRP, ANSI, ASTM, ASME, no, I'm not
13 aware of any other compartment factors that have been
14 explicitly laid out other than these.

15 Q Let's take a moment and try to answer your
16 homework questions here.

17 A Oh.

18 Q One question that the Board had was whether there
19 are any relevant publications from ICRP on this subject
20 since ICRP 26.

21 A Yes, and Dr. Cool raised this as well. ICRP 60
22 is the 1990 recommendations of the ICRP. So they've got
23 twenty-two years of thought process when into that. That's
24 ICRP Publication 60.

25 Q 6-0 for the record.

1 Does ICRP 60 change the basic dose limitation
2 system recommended by ICRP 26?

3 A The fundamental approach remains the same. There
4 are differences between ICRP --

5 MR. DAMBLY: I'll just interject an objection
6 that ICRP 60 would be the best evidence. Right now we have
7 somebody testifying about a document that's in existence.

8 JUDGE KELBER: Dr. Cool did the same.

9 MR. DAMBLY: We didn't ask the questions, but
10 that's alright.

11 MR. BROOKS: I've got it here if Mr. Dambly wants
12 me to put it into evidence. I only have one copy of it,
13 but I do have it.

14 JUDGE KELBER: On the same basis that the
15 transcript of Mr. Chastain will be supplied later, I
16 suppose this could be supplied later, could it not.

17 MR. DAMBLY: I have no problem if he wants to
18 show it to here. I mean, clearly it's a publically
19 available document. If she wants to point out where she's
20 stating it says such, we don't even need to put it in the
21 record, okay.

22 MR. BROOKS: We're just trying to answer the
23 questions that the Board posed.

24 JUDGE KELBER: Well, why don't you give her the
25 document so she can reference it.

1 BY MR. BROOKS:

2 Q Fine. For the record, Ms. Berger, I'm giving you
3 ICRP 60. If you find it useful in answering these
4 questions, go to it.

5 Does ICRP 60 change in any way the weighting
6 factors that are found in ICRP 26, the Federal Radiation
7 Protection Guidelines in 10CFR Part 20?

8 A Yes, there are changes in the organ weighting
9 factors. Based upon reassessments of the effects of
10 radiation exposure that's taken into account and the ICRP's
11 acknowledgment that there are additional organs that should
12 be called out, should be singled out as being sensitive to
13 exposure to radiation.

14 So if you look at -- in fact let me see if I can
15 find them here, maybe that's going to do. If you look at
16 the list of organ weighting factors, it happens to be on
17 Page 8 of ICRP 60, where in ICRP 26, one, two, three, four,
18 five, six, seven, there's seven organs listed. Well, six
19 plus the remainder compartment. In ICRP 60 there's now,
20 one, two, three, four, five, six, seven, eight, nine, ten,
21 eleven, twelve, plus the remainder compartment for a total
22 of thirteen. So since they all still have to add up to
23 one, any given compartment like the gonads, for example, in
24 ICRP 26 the weighting factor was .25, twenty-five percent.
25 In ICRP 60, it's now .20. Some of that weight went to

1 other organs.

2 Q So in other words, the weighting factors in ICRP
3 60 have a little bit more subtle distribution of the
4 weighting factors?

5 A I think it's a fine tuning, that's correct.

6 Q Okay. I think another question you were asked
7 was whether there are any other ICRP documents that address
8 compartmentalization.

9 A Generically speaking, there are a couple that
10 vaguely approach that.

11 The only one that really comes to mind is ICRP 34
12 and, let me see, I think I can even tell you the title of
13 that. It's General Principles of Monitoring for Radiation
14 Protection Workers. That came out also in the early '80's.

15 Basically, this is a methodology -- excuse me,
16 it's not 34. I read you the wrong one. Thirty-four is
17 Protection of the Patient in Diagnostic Radiology.
18 Basically it's a methodology for assessing radiation doses
19 to patients that only receive radiation exposure to just
20 small part of their body. There are a lot of reasons for
21 why that standard was necessary. Sometimes you have to
22 weigh the risks and the benefits of providing radiation
23 exposure for diagnostic and therapeutic purposes. That was
24 the reason for that.

25 And, they do provide dose factors based upon the

1 compartments of the body that have been irradiated. That's
2 not the same thing as the compartment factors that, for
3 example, are in ANSI 13.41, but that's the only one that I
4 know of that has some acknowledgment of the compartment
5 approach.

6 There is another one that I think is ICRP 33.
7 Once I read it, that is entitled Protection Against
8 Ionizing Radiation for External Sources Used in Medicine.
9 That's been a long time since I've looked at that and I
10 just don't know if it uses them in there or not. That was
11 issued subsequent to ICRP 26, but that ICRP document
12 pertains to protect of workers, hospital workers,
13 radiography people and X-ray technicians and I just don't
14 know if it raises -- I don't know, Cindy or the others
15 might know.

16 Q All right. The last question, I think, was
17 whether there was any guidance from ICRP on how to use
18 compartment factors specifically the cases of accidents or
19 non-routine situations.

20 A No, like I explained earlier, the ICRP doesn't
21 distinguish between an accident exposure or a routine
22 exposure, a delivered exposure all at once, an accidental
23 exposure that occurs over years, radiation dose in this
24 case is simply energy to position unit mass that is
25 weighted by relative effects of irradiating individual

1 organs in order to demonstrate or to make a comparison to
2 an effective dose equivalent limit. There is no
3 distinction between whether it's inadvertent or
4 intentional.

5 Q Dandy. I'm about to move on to --

6 JUDGE KELBER: In that case, could I interject a
7 question?

8 MR. BROOKS: Absolutely.

9 JUDGE KELBER: You have stated a number of times
10 that the assessment of a given dose or absorbed dose is the
11 same regardless of the mode in which the radiation
12 occurred. I have worked with glove boxes and I have been
13 near them and I understand your example that accidents do
14 happen in glove boxes.

15 Now have you encountered in the ICRP
16 recommendations, the Federal Guidelines or NCFR 20 any case
17 in which a different mode of dose assessment is required or
18 statutory, that is to say regulatory purposes, as opposed
19 to dose assessment or estimating health effects?

20 THE WITNESS: If I understand your question
21 correctly is there anything in the regulations of the
22 standards document that give you two different methods of
23 assessing dose?

24 JUDGE KELBER: Yes.

25 THE WITNESS: No, not to my knowledge there's

1 not.

2 JUDGE KELBER: Thank you.

3 CHAIRMAN BECHHOEFER: Let me just follow up on
4 one matter. If you say that there is nothing specifically
5 describing accidents or non-routine exposures, that being
6 so, would it not be reasonable to limit the calculating
7 doses to within the scope of the standard itself as it's
8 set forth?

9 THE WITNESS: Of the ANSI Standard?

10 CHAIRMAN BECHHOEFER: Of the ANSI Standard, yes.

11 THE WITNESS: I'm not sure that I understand what
12 you meant by that?

13 CHAIRMAN BECHHOEFER: It's my understanding that
14 the scope goes to routine occupational exposures and maybe
15 --

16 THE WITNESS: Right.

17 CHAIRMAN BECHHOEFER: -- the question in my mind
18 is should we then limit the references in Part 20, the
19 infamous footnote, to the scope of the stated scope of the
20 ANSI document.

21 THE WITNESS: I don't, if I'm understanding
22 correctly, think that that's necessary because the scope of
23 the standard addresses the totality of the standard and
24 10CFR Part 20 doesn't really give any guidance on the use
25 of multiple dosimeters. It only states that you must use

1 weighting factors when you've got a non-uniformed exposure,
2 that you have to use the weighting factors. The only thing
3 that 10CFR Part 20 says, it doesn't say you only use these
4 weighting factors in the event of routine exposures versus
5 an accident exposure. It doesn't distinguish between them.

6 MR. BROOKS: Could I just ask my witness, we're
7 about to move on to her dose calculations, do you want a
8 five minute break?

9 THE WITNESS: Oh, I'd vote for that.

10 MR. BROOKS: Would that be acceptable to the
11 Board?

12 JUDGE COLE: Sure.

13 MR. BROOKS: If that's all right.

14 CHAIRMAN BECHHOEFER: Five minute break.

15 MR. BROOKS: Thank you very much.

16 [Whereupon a short break was
17 taken.]

18 CHAIRMAN BECHHOEFER: Back on the record.

19 JUDGE KELBER: I have one other question before
20 you begin. Is there, have you encountered any situation in
21 which the C-dose from an external radiation field is
22 independent of the time of exposure?

23 MS. BERGER: In which the total dose is
24 independent of the time of exposure?

25 JUDGE KELBER: Correct.

1 MS. BERGER: No. The total dose is dependent
2 upon the time or the duration of exposure. It's the
3 exposure rate at a given location and then the amount of
4 time that's spent there. But the total dose itself, yes,
5 is a part of, has to take into account both the dose rate
6 and the duration of exposure, that's correct.

7 JUDGE KELBER: Thank you.

8 BY MR. BROOKS:

9 Q Ms. Berger, I've asked you to turn in your hymnal
10 to Exhibit 14. Have you, are you familiar with that
11 document?

12 A Yes, I am.

13 Q Good. Can you describe what it is?

14 A It's a letter to Mr. Robert Slack wherein my
15 company, IEM, provided an evaluation of the radiation
16 exposure of Mr. Chastain based upon information that was
17 provided.

18 Q And attached to that letter are your, the backup
19 for your dose calculation?

20 A Yes, assumptions and other things.

21 Q When did you prepare Exhibit 14?

22 A Well, the date on it is December 10th of 1996.
23 The actual preparation was, took place about a week or so,
24 I think, before then.

25 Q Talk to the panel. They're the ones that care.

1 What is it that Conam asked you to do?

2 A I'd gotten a call from Mr. Slack asking me is I
3 would be willing to perform an assessment of the radiation
4 dose to Mr. Chastain. He gave me some preliminary
5 information over the phone. I asked him for some more
6 specific information, if it was available, and he prepared
7 a couple of packages of stuff and mailed it to me.

8 Q Were you asked to prepare a dose calculation
9 based on a particular scenario of what we've heard here?

10 A No, he never specified the scenario. He just
11 wanted, I think the term that he used was independent
12 assessment of dose. I'm not sure what that was independent
13 of, but he described a scenario to me on the phone and
14 then, when I received the information in that package was a
15 kind of a reconstruction of events that was performed by
16 the NRC, that indicated there, that there was a different
17 scenario present. So, practically speaking, it made sense
18 to evaluate the dose for both scenarios, and so that's why
19 there are two of them in that document.

20 Q Specifically let me ask you, did Conam tell you
21 how to do your dose assessment?

22 A No. They did not.

23 Q Did they ask you to use or not use compartmental
24 factors?

25 A No. I'm not...no, they did not.

1 Q Now, are the documents that you received from
2 Conam, with respect to this assignment, listed on the first
3 two pages of your report?

4 A Yes, they are. Those are the documents that were
5 sent to me and then I used as a basis for the contents of
6 the report.

7 Q Okay, and in addition to that, you say you had a
8 telephone conversation or a couple of telephone
9 conversations with Mr. Slack?

10 A Yes, I had a couple of telephone conversations to
11 try and obtain additional information.

12 Q If I could ask you, on Page...turn to Page 2 of
13 your report. In the first paragraph, underneath where the
14 documents are, just ask you if the second sentence
15 beginning, in the first phase...does that describe your
16 basic methodology?

17 A Yes, it does.

18 Q Okay, and can you describe briefly what the two
19 phases of your methodology were?

20 A Basically, I calculated the radiation dose to the
21 organs, the compartments of Mr. Chastain's body, and then I
22 translated that into an effective dose equivalent again
23 using the compartment factors that are in ANSI 13.41.

24 Q And did you follow that methodology for both of
25 the two scenarios that you've discussed here?

1 A Yes, I did. The difference between the two was
2 in the estimation of dose to the compartments. The second
3 phase of that was identical.

4 Q Now, if I could have you turn, for a moment, over
5 to Page 5 of your, of the, of your document here. This is
6 the second page of Appendix A, is that right? Look at the
7 previous page.

8 A Okay, yes, right.

9 Q Page 4 is Appendix A, and Appendix A is your
10 methodology, includes your methodology?

11 A That's correct.

12

13 Q And if I have you look at Page 5, does that
14 describe specifically your methodology with respect to the
15 use of compartmental factors?

16 A Yes, it does. It's a summary, basically,
17 of...well, it's the same approach that's described in ANSI
18 13.41.

19 Q Okay. That's the same approach that you just
20 testified about before our break?

21 A That's correct.

22 Q Okay. Now if I could ask you to turn to Appendix
23 B. What is described in Appendix B?

24 A This is the, a summary of the approach that we
25 use to calculate the doses to the various compartments in

1 the subject's body based upon, what it's called here is,
2 initial time and motion scenario, and that was the scenario
3 that was relayed to me by Mr. Slack.

4 Q And is that the one that Mr. Slack told you he
5 heard from Mr. Chastain on February 28, 1996, the day after
6 the incident?

7 A Well, I asked him. I said, what was the exposure
8 scenario, and he described to me...at that time I didn't
9 know that came from a description at that time. He said
10 that the gentleman climbed a ladder, stood there from one
11 to four minutes facing this device, changed out film,
12 walked back down again, it was a radiography device with a
13 highly collimated beam. It wasn't until I received the
14 information from him afterwards that I saw there was a
15 second scenario.

16 Q But Exhibit...Appendix B is directed towards your
17 calculations with respect to the first scenario?

18 A Yes, that's correct.

19 Q And that scenario is where he goes up the ladder
20 for somewhere between one and four minutes, is facing the
21 camera the whole time?

22 A Yes.

23 Q Twisting and turning one way and the other?

24 A Yes. And it's with the exit port of the camera
25 pointed directly at his leg.

1 Q That was your assumption in this?

2 A That's what I thought happened, at that time.

3 Q Now, what measurements did you use for the
4 purposes of your first scenario calculation?

5 A What measurements? Well, there's only one known
6 in this case, and that's the intensity of the source. It
7 was a source that had a...it was calibrated at about 94
8 curies at the time of that incident. So, that was the only
9 known factor we had. There was a second piece of data
10 which was the film badge that was worn by the subject, and
11 there was no indication from Mr. Slack that that was an
12 invalid result, so the film badge reading was taken to be
13 valid. So, those were two important pieces of information
14 in trying to reconstruct the dose.

15 Q Now on the, on Page 7 of your report, there's
16 some measurement information there. Do you see that?

17 A Yes.

18 Q Where did that come from?

19 A That came...Mr. Slack did not provide me with
20 detailed biometric information other than the information
21 that the NRC provided to him, and I believe, I'd have to
22 look at my documents, but I think it was in an inspection
23 report, so I used the NRCs biometric information. They
24 made measurements of Mr. Slack and his leg widths and
25 distances and things like that.

1 Q Okay. Would you flip back to Exhibit 11, for a
2 moment, in your book?

3 A Yes. That's the information.

4 Q That's the biometric information that you relied
5 on?

6 A Yes, that's the information. Yes.

7 Q Okay. Did you say a moment ago, if you said Mr.
8 Slack's measurements, you mean measurements of Mr.
9 Chastain?

10 A I'd asked Mr. Slack if he'd had measurements of
11 Mr. Chastain's physical parameters and he provided me with
12 that report. The NRCs report.

13 Q Fine. Going to the top of Page 8, you reference
14 there dosimetry information. Is that the film badge result
15 that you referenced a moment ago?

16 A That's one of the pieces that's in there. Mr.
17 Chastain apparently had three forms of dosimetry. He had a
18 self reading dosimeter, he had an alarming dosimeter, and
19 then he had his film badge. Unfortunately, only one out of
20 the three of those had usable information on them.

21 Q Okay. Now, the next item is device description.
22 We've had a lot of talk here about a 94 curie source. In
23 your opening paragraph, you start with 121 curies. How do
24 you get from 121 curies to 94 curies?

25 A Well, the radioactive material that was in that

1 source decays or disintegrates, or attempts to achieve
2 stability at a given rate, meaning that half of those
3 radioactive atoms will decay to something else in a period
4 of 74 days. So, that means that this material is basically
5 disintegrating away before our very eyes. When this source
6 was standardized, the certificate that was given to be by
7 Mr. Slack, the source was standardized on January 31st of
8 1996, and at that time it was designated as having 121
9 curies of iridium 192 in it. So, I needed to make a
10 correction for the fact that it had been decaying between
11 1996 and...January 31st of '96 and the date of the
12 incident.

13 Q For the purposes of your calculation, did you
14 make any assumptions about the position of the source, vis
15 a vie the camera?

16 A Yes. And that was based upon information that
17 was provided to be by Mr. Slack. Now, I hadn't seen the
18 device and I didn't have a good picture in my mind of what
19 it looked like, but I generally know, knew what radiography
20 devices look like, and he described to me that when the
21 subject determined that the source was not in it's fully
22 retracted position, he was able to turn the crank
23 somewhere, I think he said one-half or one-third of a turn
24 to bring the source back in. And Mr. Slack gave me some
25 measurements of where it would put that source within the

1 box, within the device itself, if it had moved out one-
2 third turn or one-half turn. So I had those two pieces,
3 those were two separate pieces of information.

4 Q Okay, moving then to the bottom, the last item on
5 Page 8 of your report, computer simulation of exposure
6 scenario? What kind of a computer simulation did you do?

7 A Well, that sounds a lot higher tech than it was.
8 It's really not very complicated. It just relies upon a
9 computer to do things that we probably all ought to be able
10 to do in our heads. Basically, I used a computer to
11 estimate the dose, a computer program to estimate the dose
12 at various exposure points away from the source when the
13 photons were traveling through different types of material.
14 The iridium 192 was not completely bare. It was
15 encapsulated in a steel capsule and then, depending upon
16 what the angle of the exposure was, it either went through
17 simply steel or it was traversing through, I believe it was
18 titanium, some depleted uranium, some foam stuff, and
19 another layer of steel in the face plate. So, this
20 computer makes it easier to do those calculations.

21 Q And I want to come back to that point in just a
22 moment, because I think it's important. But, listed on the
23 top of Page 9, are those the assumptions that you put into
24 your computer simulation?

25 A Yes. That's a list of assumptions, yes.

1 Q Okay. We talked about the 94 curie source, the
2 source to dosimeter distance, 37.64 cm, why did you write
3 that that's the most conservative value related to the RSO?

4 A I believe, now I have to stop and think now why I
5 said that that way, but I think that the RSO indicated that
6 the individual may have been between this many inches and
7 this many inches from the source, and I wanted to get him
8 as close to it as possible.

9 Q Okay. And when you...

10 A But now when I look at that, I'm sorry, that may,
11 in fact, have been the closest distance provided in the NRC
12 evaluation. I'm not sure, I'd have to go back and check.

13 Q When you say most conservative in your report
14 here, does that mean the one most likely to yield a higher
15 dose calculation?

16 A Right. I used this, that term throughout this
17 report, and that's a good point as it should be clarified,
18 that whenever the term conservative is used, it means an
19 assumption has been selected to inflate or increase the
20 dose as opposed to reduce the dose.

21 Q Your next item is an exposure duration of four
22 minutes. Now, I heard you say a moment ago that Mr. Slack
23 told you the duration was one to four minutes?

24 A Yes, and so I assumed, again, the most
25 conservative value, or the value that was inclined to

1 overestimate the dose, and assumed an exposure duration of
2 four minutes.

3 Q Your next item is source capsule at one-half
4 turn. Why did you assume that?

5 A Well, that's also conservative, meaning designed
6 to increase rather than decrease the dose because, for the
7 one-half turn on the crank, that extends the source
8 farthest out in the tube, closest to the end of the device
9 at the faceplate of the device. Meaning there would be
10 less shielding there than there is with the source
11 retracted back farther.

12 Q What specific information did you assume or use
13 for the purposes of shielding?

14 A Mr. Slack faxes, actually I can't recall if you
15 faxed it to me or if the supplier faxed it. Maybe the
16 supplier faxed it to Mr. Slack and then he faxed to me, a
17 drawing of this device. It was a, kind of an engineering
18 drawing, they gave all the thicknesses and the dimensions
19 and the materials that were in there.

20 Q How was that information used in calculating the
21 effective shielding?

22 A I used the thicknesses provided in that drawing
23 to determine how much and what type material the photons
24 from iridium 192 had to pass through before they got to
25 whatever the dose point of interest might be.

1 Q Does that mean that for the purposes of your
2 computer program it will factor in different levels of
3 shielding depending on the vector of the radiation from the
4 source?

5 A In essence, yes. You tell the computer, I have a
6 source of this intensity, I'm interested in a dose at this
7 point and I have these kinds of shields in between it.
8 And, yes, it does do that.

9 Q Okay.

10 A The shields may include, and does include in many
11 cases, air. Because there's an air space there as well.

12 Q Now, using all those variables, what conclusions
13 did you come to with respect to his first scenario?

14 A This is not unreasonable for dose
15 reconstructions, is that somebody relays the circumstances
16 regarding an exposure, and when you try to reconstruct it
17 and make all the pieces fit, they just simply don't fit.

18 Q Well, let's look at that in terms of your first
19 calculation using those variables. Is that addressed on
20 Page 9?

21 A Yes. That's addressed on Page 9. That's where I
22 use the description exactly as, these bullets that are on
23 Page 9, I used all of those assumptions and tried to use
24 the computer to calculate the dose to the film badge where
25 it should have been, as described in this scenario. And as

1 it turned out, the dose that the computer predicted was
2 quite a bit higher than the dose that was actually on the
3 film badge, so since radiation dose at any given point is
4 directly proportional to time, distance, shielding and
5 source intensity, something had to give, so we would have
6 to...something was not quite correct there.

7 Q So in other words, when you used all those
8 variables, to put it in the vernacular, it didn't compute?

9 A It didn't compute, that's correct.

10 Q Okay. What conclusion did you come to as a
11 result of the fact that you couldn't make that first set of
12 variables compute?

13 A Either that the subject was standing farther away
14 from the source than was relayed to us, or he was not
15 standing there for as long as four minutes, as I had
16 assumed.

17 Q So did you try another calculation varying one of
18 those things?

19 A I varied it slightly on distance, but it was
20 really time. I did a second calculation that said that,
21 you know, if you keep the body at that same distance but
22 reduce the exposure duration to about a minute, then the
23 scenario starts to match. Then the film badge will read
24 what the computer program predicts for dose at that same
25 point.

1 Q And if you did it that way, what kind of a dose
2 to various parts of his body, or various compartments of
3 his body, did you calculate?

4 A Well, if we take the film badge as being
5 representative of the dose to the abdomen, then that was
6 the result that was assigned to the abdomen. But I'd have
7 to look back here somewhere.

8 Q You can take a look at Page 10, I think, if that
9 helps you.

10 A Okay. All right. And then...let me, can I back
11 up just a little bit?

12 Q Sure.

13 A Because I think there's another step in there we
14 might have skipped.

15 Q Okay.

16 A Even though I adjust the time down to one
17 something minute, again, the purpose for that was to make
18 the computer code read exactly the way the film badge read,
19 cause that's the only known that we have.

20 CHAIRMAN BECHHOEFER: Is that one minute
21 precisely?

22 A I think it was...I reduced it to one minute, and
23 I ended up with a dose to the film badge of 4.26 REM. If I
24 reduced it to a one minute exposure duration.

25 JUDGE KELBER: So if you had reduced it to a one

1 minute and then...

2 A A 1.08 minute, yeah. So, basically, what I did
3 here, is I said that well, I'm going to juggle the time so
4 that I can make this computer, this exposure scenario
5 identical to what the film badge read. Then I kept all of,
6 you know, all of those parameters the same, but I changed
7 only the distance from the source in the device to his
8 thigh, as relayed in the NRC reconstruction, changed, you
9 know, only the distance, and the shielding. Because
10 there's no shielding. Because it was a line of sight
11 direct...well, a little bit of shielding, there was the
12 encapsulation of the source was included. But, that was
13 the only other change I made, and then I took the reading
14 right off of the computer code and adjusted it for the 1.08
15 minute exposure. And got a dose to the right thigh of
16 9.369 millirem, and I assumed that for that entire
17 duration, that 1.08 minute duration, the subject was facing
18 the output port of the device.

19 BY MR. BROOKS:

20 Q Now you say you assigned to the abdomen
21 compartment, the film badge dose of 4.6?

22 A Yes.

23 Q And then you assigned to the right thigh the dose
24 of 9.3 REM?

25 A That's correct.

1 Q Did you assign any doses to any other
2 compartments?

3 A No. I thought that might have been a...well, yes
4 I did. But it might have been asking more out of the
5 available information than we could have gleaned, so the
6 subject indicated that the exposure rate in the vicinity of
7 the device on all the other sides, wherever he would be
8 standing, was about 20 millirem. So I just assumed that
9 that would be the dose to all of the rest of the
10 compartments, the head and neck compartment, upper arm
11 compartment, thorax compartment. I didn't adjust distances
12 in that case.

13 Q I'd like you to then, did that complete then, the
14 first phase of that calculation? That is, the computation
15 of the doses to various compartments?

16 A Yes. That gave me doses to all of the
17 compartments that are listed in the ANSI standard.

18 Q Okay. If I could have you turn back to the
19 second to the last page of this document, then. Now, it's
20 Attachment 1 to Appendix D? Is that right?

21 A Yes. That's correct. Page 34, right?

22 Q Page 24.

23 A Twenty-four, yes. My eyes aren't good.

24 Q Okay. What is shown on that page?

25 A This is a table that lists the compartments by

1 name and it gives the estimate of dose to that compartment
2 either by the film badge result or calculation or just
3 assuming that the 20 millirem per hour was applicable to
4 the remaining compartments. I multiplied that by the
5 compartment factor out of ANSI N13.41 to come up with the
6 dose for that compartment, and then just summed up all of
7 the compartments to arrive at a effective dose equivalent
8 of 2.3 REM.

9 JUDGE COLE: What page is that on?

10 A That's Page 24.

11 MR. DAMBLY: It's the next to the last page in
12 the document. There's a lot of unnumbered pages and stuff
13 in between.

14 JUDGE COLE: Thank you.

15 A Oh, you're right. There is.

16 MR. DAMBLY: Trust me. I've had trouble trying
17 to figure out where I was in that document many times.

18 A That's a good point.

19 JUDGE COLE: Numbered page 24, correct?

20 A Yeah, I'm sorry. Sorry about that. Yeah.

21 MR. BROOKS: It's the second to the last page of
22 the Exhibit, of Exhibit 14, I'm sorry.

23 BY MR. BROOKS:

24 Q Let's just look through this once. The, I think
25 there are four columns in your Attachment 1, right?

1 A Yes, that's correct.

2 Q And the first one says, area of the body. Does
3 that refer to the various compartments?

4 A That's the compartment description.

5 Q Okay. And then the second column is
6 compartmental dose?

7 A Yes. That's the dose that was assigned to that
8 compartment.

9 Q And how did you get the .33 millirem that is
10 assigned to the head and neck, thorax, upper right arm,
11 upper left arm and left thigh compartments?

12 A I assumed that the exposure rate to those
13 compartments was 20 millirem per hour, and I just adjusted
14 it for an exposure of 1.08 minutes.

15 Q And that's what Mr. Chastain had said he read
16 with his survey meter?

17 A Yes. That was a simplifying assumption.

18 Q Okay. And then the assigned dose compartmental
19 dose to the abdomen is 4,600 millirem, or 4.6 REM?

20 A It's 4.6 REM to that compartment. That's
21 correct.

22 Q That's off the film badge?

23 A That's off the film badge.

24 Q Okay. And then the right thigh dose is 9.369
25 REM?

1 A That's correct. That was by calculation.

2 Q Okay. That's what you just testified you
3 calculated using the computer program?

4 A That's correct.

5 Q Okay. And then the compartment factor column,
6 where does that come from?

7 A That comes directly out of ANSI N13.41.

8 Q And then the last column, estimated effective
9 dose equivalent, is simply a mathematical computation from
10 multiplying the second column times the third column?

11 A That's correct. You multiply column two by
12 column three, you end up with a column of numbers in column
13 four and you just add those all up. And that gives you the
14 estimated effective dose equivalent.

15 Q And in this case, the effective, estimated
16 effective dose equivalent is 2.347 REM?

17 A That's correct.

18 Q And how, and that's expressed as an equivalent to
19 a uniform whole body exposure?

20 A That's correct, yes.

21 Q So that for the purposes of comparing to the 5
22 REM standard for annual dose limitation in 10CFR Part 20,
23 at this point, you're talking apples and apples?

24 A That's correct. They're the same basic premise
25 there, yes.

1 Q Now you said you made a second set of
2 calculations, is that correct?

3 A Yes, I did.

4 Q If I could ask you to turn to numbered Page 14,
5 more than 14 pages back. It's Appendix C.

6 MR. BARTH: C?

7 MR. BROOKS: C.

8 MR. BARTH: Page 14?

9 MR. BROOKS: It's numbered Page 14, which is
10 actually not real page 14.

11 MR. BARTH: Thank you.

12 BY MR. BROOKS:

13 Q Let me ask you before we get to that. Just
14 preceding numbered Page 14 are a number of what look like
15 computer printouts in Attachment 1 and Attachment 2 to
16 Appendix B. What are those?

17 A Yeah. These are just the summary reports from
18 the computer code that I used to, just to calculate the
19 exposure rate at various distances from that source.

20 Q Okay. Are we all at Appendix C now?

21 Ms. Berger, what is expressed in Appendix C to
22 your report?

23 A It's almost the same thing as the previous dose
24 assessment. It's just that, in the inspection report from
25 the NRC a second scenario was put forth, where the subject

1 climbed the ladder, faced one direction for one minute, and
2 then turned around and faced another direction for another
3 minute, meaning...

4 Q For three minutes.

5 A Or, excuse me, for three minutes, yes, that's
6 correct. I think they may have said a range, but I think
7 that the maximum was like one minute in one direction and
8 three minutes in the other direction for a total of about
9 four minutes. And so, this is just a, the same type of
10 calculation but using that exposure scenario.

11 Q Okay. And I think we've heard a lot of testimony
12 about that scenario. If you could turn to Page 17 of your
13 report. Using your calc...in calculating doses for this
14 second scenario, what dose did you assign to the abdomen?

15 A Well, the abdomen we still assigned a dose of 4.6
16 REM because that's what the dosimeter read which was
17 positioned within the abdomen. That was a valid piece of
18 data.

19 Q Now did you come up with a dose to the right
20 thigh?

21 A Yes. There was, let me back up to that abdomen
22 dose. I should probably mention one thing. As he turned
23 around, the dosimeter is no longer on the front of the
24 body, and so I guess technically speaking, we should have
25 done a two-phase calculation there, but the fact of the

1 matter is, is that the, another simplifying assumption is
2 that a dosimeter placed in a compartment is reasonably
3 representative of the dose to that compartment, so that was
4 the same simplifying assumption I used for abdomen.

5 Q Now, how about for the dose to his right thigh?
6 Did you have to compute that?

7 A Yeah, the dose to the right thigh was done,
8 again, using the same relationship of dose to source
9 through various layers of shielding for the duration that
10 was expressed. In this particular case, his right thigh
11 was irradiated for the one minute that he was facing the
12 device. When he turned to the other side, we now have got
13 a beam of radiation that's travelling a greater distance so
14 I had to make a second calculation there.

15 Q Now again, for these calculations, did you
16 assume, as you did for your first set of calculations, a
17 collimated beam?

18 A For the right thigh, while he was in the one
19 minute position it was a collimated beam, yes.

20 Q Okay. And then when he turned around, did you
21 continue to assume a collimated beam?

22 A For the back of the left thigh at that point.

23 Q Okay.

24 JUDGE KELBER: Excuse me. The way I understood
25 it, this code does a point to point survey go along a

1 vector from one point to there computing the shielding
2 factors from a given source. Is there some provision in
3 there for specific field geometry?

4 A Yes.

5 JUDGE KELBER: You used the term collimated beam.

6 A Well, there's, it gives you a whole choice of
7 field geometries. The one that was picked was a point
8 source.

9 JUDGE KELBER: You used a point source.

10 A I used a point source, so I have a source that's,
11 in essence, a point, and a dose point that's also a point.

12 JUDGE KELBER: Okay.

13 A So I see what you're saying. I guess we were not
14 precise with our words there.

15 CHAIRMAN BECHHOEFER: Now, are you through?

16 JUDGE KELBER: Yeah.

17 CHAIRMAN BECHHOEFER: I have, again, I need some
18 clarification. When you talk about three minutes in one
19 way, three minutes he was facing backwards on the ladder or
20 forwards? That's what I'm trying to figure out.

21 A My understanding of the scenario at that time,
22 and if I could look at it, I think you said it was 11?

23 MR. BROOKS: Yes, Exhibit 11.

24 A Exhibit 11.

25 MR. BROOKS: Judge Bechhoefer, I think Exhibit 11

1 was the document that either Mr. Young or Mr. West
2 testified summarized the reenactment on April 11th and the
3 measurements and the observations made on April 11th which
4 the staff then sent to Conam as a recordation of the
5 observations and measurements made on April 11th.

6 A In this document on the second page, it states
7 that the subject was in orientation A for one minute, and
8 orientation B for three minutes. I took orientation A to
9 mean he was standing on the ladder facing the device. In
10 orientation B, he turned around on the ladder to do
11 something, and so his back was to the device.

12 CHAIRMAN BECHHOEFER: Now, did you then take into
13 account in determining, I shouldn't say validity of this,
14 the appropriateness of the 4.6 reading that there be some
15 shielding? Maybe shielding is not the right word. -- body
16 shielding anyway.

17 A No, it's the correct word, yes. I did. For, in
18 order to reproduce the film badge reading, to make sure
19 that the computer model was set up correctly, we have the
20 personnel dosimeter facing forward for one minute, and then
21 we had to do a second calculation with the gentleman
22 turning back, meaning the film badge is now farther away
23 and there's the thickness of his body, and, again, I
24 believe that in Exhibit 11 they give...yeah, they do give
25 his body thickness along the source film badge. This is a

1 nice set of measurements here, is 8.75 inches. So I
2 included 8.75 inches of tissue then, in the three minute
3 measurement.

4 CHAIRMAN BECHHOEFER: I see.

5 A If I said that clearly.

6 CHAIRMAN BECHHOEFER: Okay.

7 BY MR. BROOKS:

8 Q Using your calculations, and assuming this four
9 minute set of exposures, what compartmental dose did you
10 calculate for Mr. Chastain's right thigh in this second
11 scenario? Do you want to look on Page 17 of your...

12 A In this case the dose to the right thigh was 4.8
13 millirem.

14 Q 4.8 what?

15 A Or 4.8 REM. I'm sorry.

16 Q Okay. And if you'd turn to Page 18, what dose
17 did you calculate to his left thigh compartment?

18 A The dose to the left thigh here was 41 REM. And
19 the reason why that's so much higher...

20 Q Take a look again, is it 41 or 42 REM?

21 A Total compartment, I'm sorry, 42.075, yeah.
22 42,000 millirem. That's correct.

23 Q Okay. Why is that so high?

24 A That's higher because we had...because in order
25 to get the film badge to be reading 4.6 REM with this big

1 thickness of body in between it, there had to have been
2 quite a bit greater irradiation of the thigh which was in
3 the direct line of sight of the beam than for the first
4 scenario where the film badge is remaining positioned
5 closer to the source for the entire duration.

6 Q You again, when you're using this four minute
7 time scenario, you've got problems making it all compute?

8 A That's right. It still doesn't work for four
9 minutes. You still end up not being able to duplicate the
10 film badge reading in those cases if you assume a four
11 minute exposure, so since we couldn't adjust the source
12 intensity and it didn't seem reasonable to adjust the
13 distances, because I just couldn't picture him leaning back
14 and forward too far on a ladder. Time seemed to be the
15 thing, most likely, that was in error.

16 JUDGE KELBER: If you adjusted the time so that
17 the total dose recorded in the film badge, the sum of the
18 dose received in the both orientations was 4600, what then
19 would be the dose to the left and right thighs?

20 A If I did the adjustment? That's where I came up
21 with these numbers here of 42 REM.

22 JUDGE KELBER: That's what the median dose was?

23 A Yes. That includes, yeah, that, I had to make an
24 adjustment in a time, a factor of 2.58 I think it was in
25 adjustment, in order to make the film badge read, in order

1 to calculate a dose at the point of the film badge that was
2 equivalent to the film badge reading.

3 BY MR. BROOKS:

4 Q If I could ask you turn then to the...I'm sorry,
5 go ahead.

6 CHAIRMAN BECHHOEFER: I was just wondering, so
7 you did this for, say a total of two minutes in both
8 positions? We had some demonstrations that, yesterday,
9 that showed that two minutes was probably even more than
10 the exposure, but be that as it may, two minutes is
11 convenient?

12 A Right. What I, in essence, did is used the
13 computer model to calculate the dose to the body at the two
14 locations where the film badge was. And then I, you add
15 those up and you look to see, do you get 4.6 REM, you
16 don't. You grossly overestimated that by a factor of 2.85.
17 So, I just then went on and calculated the dose for the
18 right thigh and the left thigh but adjusted them by that
19 factor of 2.85.

20 CHAIRMAN BECHHOEFER: Okay.

21 MR. BROOKS: Five eight.

22 A 2.58, I'm sorry.

23 BY MR. BROOKS:

24 Q If I could then ask you to turn to the last...

25 JUDGE KELBER: Excuse me, just let me explain.

1 That means a total time of approximately one minute and a
2 half.

3 CHAIRMAN BECHHOEFER: Oh, okay. We saw something
4 for that. That's fine.

5 BY MR. BROOKS:

6 Q Could I ask you then to turn to the last page of
7 Exhibit 14?

8 JUDGE KELBER: Is that a numbered page, Mr.
9 Brooks?

10 MR. BROOKS: It's numbered Page 25. I hope.

11 MR. DAMBLY: I'm sorry, which page?

12 MR. BROOKS: Numbered Page 25 which should be the
13 last page of Exhibit 14.

14 BY MR. BROOKS:

15 Q What is represented on Page 25?

16 A This is another evaluation of the effective dose
17 equivalent based upon the assessments of the doses to the
18 various compartments.

19 Q And again here you've assigned the background
20 radiation doses to the head and neck, thorax, upper right
21 arm, upper left arm compartments?

22 A Yes, I did.

23 Q And where do the right thigh and left thigh
24 numbers come from?

25 A That's done by calculation. The only one that's

1 done by measurement is the abdomen.

2 Q Okay. And then you followed the same procedure
3 of using the compartment factor specified in ANSI 13.41?

4 A That's correct. They're the identical
5 compartment factors.

6 Q So based on the time and motion study conducted
7 by the staff on April 11, 1996, what dose do you calculate
8 that Mr. Chastain received?

9 A In this case it would be 2.5 REM, effective dose
10 equivalent.

11 Q I'm going to move on from this report. If
12 anybody's got any other questions on this report...

13 JUDGE KELBER: Are you moving on from this
14 report?

15 MR. BROOKS: Yes.

16 JUDGE KELBER: I have some questions.

17 MR. BROOKS: Okay. Well, I'll be asking one more
18 question.

19 JUDGE KELBER: Turning back to Page 9, I note
20 that there is a footnote which refers to one other -- of
21 this problem, that is the question of whether the source
22 was at the one-third turn position or the one-half turn
23 position. Would you summarize what you found from the one-
24 third turn position and...well, that's that, that's it, and
25 just summarize that, please?

1 A When you're at the one-third turn position, the
2 radiation dose at set distances is lower than at the one-
3 half turn position. Even directly in front of the exit
4 port of the camera the dose is back a little ways so the
5 exposure would be lower there. But if I move up and
6 around, I start to go through thicker layers of shielding
7 when I'm back farther into the camera. You can see a
8 little bit on that cut open one there, but you can see the
9 source pulls back in to where there's more, the primary
10 driver is the depleted uranium, where there's more depleted
11 uranium for the photons to go through, and therefore
12 there's more absorption.

13 JUDGE KELBER: Did you consider interpellating
14 between the one-half and one-third turn position because I
15 understand the description to have been rather imprecise,
16 to find a position where without modifying the scenario in
17 any other way, you would get the 4.6 REM on the film badge?

18 A I couldn't do that easily between the one-third
19 and one-half position.

20 JUDGE KELBER: Then your interpellation is
21 obviously, in this case, not correct.

22 A Yeah, I suspect.

23 JUDGE KELBER: So you would have to have made a
24 number of trials?

25 A That's correct. And...yes.

1 JUDGE KELBER: Why wasn't that done? Because you
2 varied the other parameters.

3 A To be real honest, I simply wanted to create a
4 set of exposure scenarios that would give me a dose that
5 was reasonably equivalent to what was on the film badge.
6 Once I achieved that, I can then go on and calculate the
7 dose at different points, once I have what that adjustment
8 would be. And I'm literally applying a correction factor.
9 I think the bottom line is that the correction factor takes
10 into account the fact that there may be some variability in
11 the position of the source and there may be some
12 variability...well, let me back up.

13 It's more in the variability of the time. You're
14 correct. If I vary the position of the source, I am going
15 to vary the shielding. And so, I guess I've talked myself
16 into saying, yes, that's good advice. Perhaps that would
17 have been an interesting thing to have done, was to have
18 performed calculations at various points.

19 JUDGE KELBER: Does a Microshield code require
20 the use of any arbitrary parameters other than the physical
21 parameters you have described here?

22 A The Microshield code is pretty straightforward.
23 You give it a source strength, you give it a distance where
24 you want to measure the dose and then you tell it how many
25 shields are between it, what type of shield, what the

1 density of those shields are, what the thickness of those
2 shields are. And that's pretty much it. It's pretty
3 straightforward.

4 JUDGE KELBER: Considering the sensitivity, the
5 apparent sensitivity of the computed dose to the position
6 of the source within the sigmoid curve from the exit port
7 to the locked position, may this problem be accurately
8 described as a problem in labyrinthine shielding?

9 A Yes. It's heavily a labyrinth shield type
10 problem, because you've got the streaming beam and then
11 you've got a dense shield around it.

12 JUDGE KELBER: Are such shielding problems novel
13 or of a previously unknown type?

14 A No. As a matter of fact, they're not.

15 JUDGE KELBER: Are there a variety of methods, of
16 which Microshield might be an example, that are used to
17 analyze such?

18 A Yes, they are.

19 JUDGE KELBER: They're in the standard
20 literature?

21 A That's correct.

22 JUDGE KELBER: Yes, I wrote some of that. Okay.
23 Just one more final gratuitous remark. Rocket science
24 ain't all that hard.

25 BY MR. BROOKS:

1 Q Ms. Berger, let me ask you if, having gone
2 through this report, and based on the assumptions that you
3 made in this report, if you have an opinion as to the most
4 likely dose that Mr. Chastain received in this incident?

5 A The most likely dose that he received?

6 Q What do you think is the right dose that Mr.
7 Chastain received in this incident?

8 A Based upon the calculations that are in this>

9 Q Yes, ma'am.

10 A I would have to pick scenario one, which
11 was...what was the bottom line in that one, 2.3 REM? 2.3
12 REM for scenario one. And my basis for that is, in my
13 experience in interviewing people after radiation incidents
14 and things, that their first indication of what happened is
15 typically the clearest. And that's the only basis that I
16 have for picking that scenario over the second one. I
17 really can't honestly say if Mr. Chastain just didn't
18 become clear as time went on. That may have been the case,
19 but in my experience usually the first, the first relaying
20 of the incident tends to be most accurate.

21 Q Have you had a chance to look at the calculation
22 performed by the staff, Mr. West, in this matter?

23 A Yes. I did not receive that with the original
24 package of information. It was actually May or June or
25 something of this year when I...

1 Q Neither did we.

2 A Oh, okay. Yes, I did look at that.

3 Q To what extent is the methodology similar or
4 different from yours?

5 A Well, there's quite a bit of similarities, and
6 it's a perfectly reasonable calculation. They relied upon
7 an inverse square relationship between a dose at the
8 various points. They also relied heavily on the dosimeter
9 as being a valid data point. And, I guess the biggest
10 similarity is that it used the one and three minute
11 exposure scenarios facing forward, facing back. So, yeah,
12 they're very similar.

13 Q Does the staff's calculation make different
14 assumptions than yours about the nature of the radiation
15 field?

16 A The way in which that calculation was performed,
17 the simplifying assumption that was made there is that the
18 radiation field was somewhat homogenous, and therefore they
19 used simply an inverse square to predict the dose at the
20 film badge and then again at the various other points on
21 Mr. Chastain. And that's a note, I don't take exception to
22 that simplifying assumption, it's just that technically,
23 when you moved, you moved through different layers of
24 shielding, so the dose rate at the various points around
25 that source is a little bit variable. But in light of the

1 other discrepancies and difficulties in this dose
2 assessment, I, it wasn't an unreasonable assessment. Or,
3 it wasn't an unreasonable approach.

4 Q Can we tell from the evidence that we have what
5 the characteristics of the radiation field, strike that.
6 Your assumption was that there was a collimated beam?

7 A Yes. I made an assumption that there was a
8 collimated beam and that the individual was standing facing
9 the collimated, the exit port of the camera.

10 Q Can we tell whether your assumption or the
11 staff's assumption was correct?

12 A Unless we've got a secret videotape of when this
13 incident occurred, no. Either one. We can go either way.

14 JUDGE KELBER: May I interject a question?

15 MR. BROOKS: Absolutely.

16 JUDGE KELBER: Since you were discussing the
17 staff's assessment, reconstruct, those reconstructions, I
18 should say. You were able to correct, to predict a dose on
19 the film badge, and then you were able to correct the
20 calculated doses by applying a factor. Is this because the
21 dose was linear in time?

22 A Yes. That's correct.

23 JUDGE KELBER: Could you do the same with the
24 staff's assessment for different...when they changed
25 positions?

1 A Could I...

2 JUDGE KELBER: In other words, did the staff, for
3 a given source, predict the film badge to be 4600 millirem?

4 A Yes, they did. They had, well, what the staff
5 did is it set up the exposure parameters of time, distance
6 and shielding, and then where I adjusted a parameter that
7 really influenced time, the staff adjusted the parameter
8 that influenced source strength.

9 JUDGE KELBER: Now, if you keep the source
10 strength constant and change the distance, would the
11 staff's estimated dose change?

12 A Yes, it would.

13 JUDGE KELBER: Did they do that?

14 A No, they didn't. They adjusted the source
15 strength and in order to make the film badge read the way
16 the calculation predicted it to be.

17 JUDGE KELBER: I see. So that the dependence on
18 time was not apparent?

19 A No. They used the three minute and one
20 minute...if I could refer to that. I don't know what
21 exhibit number it is in here, but I believe they used the
22 three minute and the one minute time.

23 JUDGE KELBER: Okay.

24 A Interestingly enough though, on that scenario the
25 adjustment in time that I had to make to make it work out

1 with the film badge reading, I had to make about a 30
2 something percent correction in time and the staff made
3 about a 30 something correction, percent correction in
4 source strength. So again, it's a balancing of time,
5 distance, shielding and...

6 JUDGE KELBER: Because exposure is linear in the
7 source strength.

8 A That's exactly correct.

9 JUDGE KELBER: So for any given orientation, the
10 two methods are equivalent.

11 A That's correct.

12 JUDGE KELBER: If you compare different
13 orientations, however...

14 A Then they get different because the staff, then,
15 assumed that same source strength simply moving to a
16 different dose point, but as you can see on the device, you
17 now are starting to add more shielding. So that's the only
18 difference in that case.

19 JUDGE KELBER: Okay.

20 A It appears to me that the staff might have been
21 assuming sort of an isotropic field.

22 JUDGE KELBER: Yes. Okay.

23 BY MR. BROOKS:

24 Q Let's look at the big picture here and we'll
25 finish up, you and I.

1 A That's a good idea.

2 Q You were present at the reenactment on April 26,
3 1998?

4 A At Ely Lily, yes, I was.

5 Q Ely Lily.

6 A Yes, that's correct.

7 Q August 26th, sorry.

8 A August 26th.

9 Q Thanks. See anything there that gave you a new
10 or different outlook on this matter?

11 A Well, actually I first became a little bit
12 concerned that I may not have had the right exposure
13 scenario when I saw the staff report. There was a drawing
14 in there that showed the, there was a figure standing on a
15 ladder, and it showed the device pointing off to the side.
16 And when we got to the Ely Lily facility, that was the
17 first time I saw the pictures that were there, and saw that
18 the device was bigger than I thought and it was pointed
19 sideways.

20 There, that was an interesting revelation, and
21 then also, too, I was concerned why I had to make these
22 adjustments in time. Why I had to, why the four minutes
23 weren't good and why one minute was better, and in watching
24 the radiographer perform the process three times, he ended
25 up with being on the ladder in the immediate proximity of

1 the device, for about a minute, minute and thirty seconds,
2 something along those lines, so that made me feel a little
3 bit better about time. The time was probably closer to
4 between a minute and two minutes than it was one to four
5 minutes. But, when he was on that ladder, he was standing
6 pretty much to the side of the box, and that was a
7 different scenario than I had envisioned.

8 Q If it were you making a judgement about the dose
9 that Mr. Chastain received, and if he was, in fact,
10 irradiated by a uniform field of radiation, an isotropic
11 field, what judgement would you come to about the dose that
12 he received?

13 A Well, I wouldn't make any judgements, I'd take
14 the film badge reading at 4.6 REM.

15 Q Why?

16 A That's the fundamental basis of personnel
17 dosimetry is if you're in a reasonably homogenous field,
18 the film badge is representative of the dose to the
19 individual. If we try to dissect that and fine tune that
20 to terribly much we're creating a personnel dosimetry
21 program that licensees would just be horrified to get into
22 and probably the NRC would find to be a terrible can of
23 worms. So, it's common practice, when you're in a
24 reasonably homogenous field to assume that the single film
25 badge is giving you a reasonable assessment of the dose to

1 the entire body.

2 Q Now you said that if you don't assume the film
3 badge result you create problems for the licensee. What
4 kind of problems are you talking about?

5 A Well, then the licensee has to start watching the
6 employees to see, well how long did they face the source?
7 How many minutes were they there? Were they standing
8 forward? Were they standing backwards? We're starting to
9 create a dosimetry program that is a lot more complicated
10 than conventional external dosimetry, which now is very
11 simple. It's a very simple method, it's been very simple
12 for many, many years.

13 Q If you take the film badge result, does that give
14 you a simple way of understanding your reporting
15 requirement?

16 A If...I'm sorry. Say that again?

17 Q If you take film badge results, as you
18 recommended, does that give you a simple way of
19 understanding and complying with one's reporting
20 obligations?

21 A Yes. Most licensees, my company's a licensee as
22 well, we report the film badge reading right from the
23 dosimeter processor. We do not adjust that unless we've
24 got justification to adjust it.

25 Q Thank you very much, Ms. Berger. I appreciate

1 all your time.

2 JUDGE COLE: Ms. Berger, early on you mentioned
3 your experience at Oak Ridge and excessive doses using
4 compartmental factors. You were working with the
5 Department of Energy at the time?

6 A I was working for a contractor to the Department
7 of Energy. It was originally working for Union Carbide
8 Corporation and then the contract was awarded Martin
9 Marietta.

10 JUDGE COLE: And at that time, the Department of
11 Energy had requirements as to how to calculate dose that
12 included the use of compartment factors?

13 A The Department of Energy had orders but not a lot
14 of explicit instruction on how to do things like that.
15 That's part of why every facility was kind of winging it on
16 their own, but there were, I believe there was a Department
17 of Energy order dated in the 80's, and I can't, I'm just
18 going on memory now, that required the use of the ICRP 26
19 waiting factors for assessing effective dose equivalent
20 from organ doses. And there may have had been some
21 guidance eventually have come from the operations office
22 telling us perhaps how to implement that, but early on that
23 guidance wasn't there and we just created our own
24 compartment factors.

25 JUDGE COLE: Did they have limits as to annual

1 dosage and -- doses?

2 A Absolutely. Yes, there were, those limits were
3 also consistent with the recommendations of the ICRP.

4 JUDGE COLE: With your knowledge, do you have a
5 knowledge of what the requirements are for different
6 agencies of the U.S. Government with respect to dose
7 limits?

8 A I believe that all of the federal agencies are,
9 use the same dose limits that are in ICRP 26 and 30.

10 JUDGE COLE: All right. Do...other than the NRC,
11 do you have knowledge of how the other agencies of
12 government, and if they use and how they use compartment
13 factors in their dose assessments?

14 A I have specific knowledge of one, DOE operations
15 office, only because I've gotten calls from them when they
16 were putting together their guidance on that, and they are
17 doing exactly the same thing that's in the ANSI 13.41
18 document.

19 I also have knowledge from a couple of states.
20 They're, state agencies, state's regulate the use of X-
21 rays, diagnostic X-rays. That's not an NRC, NRC doesn't
22 regulate that, and the states, I don't know how many of
23 them but I know of a few, specifically that do authorize
24 the use of compartment factors when you are doing
25 diagnostic work like fluoroscopist or CAT scans or

1 something where you've got a lead shield over the body.
2 So, they do authorize the compartment factor. It's not
3 equivalent, none of the states use an equivalent factor to
4 the ANSI 13.41.

5 JUDGE COLE: Okay. Let me tell you the reason
6 for my question. You see, I have no knowledge of what the
7 other agencies are using, I only know of what the NRC
8 documents say, and I wanted to try to determine if NRC is
9 unique in their position, and possibly for good reason, but
10 are they unique in their assignment of a waiting factor of
11 one for external dose calculations?

12 A If I take...

13 JUDGE COLE: If you don't know, that's fine.

14 A Well, if I take a global interpretation, I think
15 the intent of that regulation is consistent with everybody
16 else's. Which is, if you've got no reason to think that
17 the uniformity of that field is in question, you don't need
18 to apply a waiting factor. But they haven't explicitly
19 laid any out. Only under other circumstances have other
20 agencies actually laid out other compartment factors in
21 that case. But I hate to compare federal regulation to
22 federal regulation. I personally find the NRCs regulations
23 in 10CFR Part 20, to be far more user friendly than the
24 Department of Energy regulations. And, in fact, they're in
25 the process of, I'm sure when the NRC was trying to arrive

1 at 10CFR Part 20, there was a lot of cross talk between
2 them and the Department of Energy on understanding some
3 interpretations of ICRV26.

4 JUDGE COLE: They've been doing that for years.

5 A Yeah, I imagine so. But, I don't want to say
6 that the NRCs regulations are better than all of the other
7 ones, I am more used to them because I work with them and
8 with agreement state regulations more so than I do
9 Department of Energy, but I think the intent is similar and
10 I just think that a literal interpretation of that creates
11 a problem, and I believe that's unique to 10CFR Part 20.

12 JUDGE COLE: Thank you.

13 CHAIRMAN BECHHOEFER: Before cross examination,
14 I'd like to take about a five minute break.

15 MR. DAMBLY: Honestly, Judge, if we're going to
16 take a five or ten minute break, which I would like, before
17 we start this, why not take the lunch hour now, rather than
18 break again in a half an hour.

19 JUDGE COLE: Well, it's a little early for lunch.

20 MR. BROOKS: Dennis, how long do you have, do you
21 think?

22 MR. DAMBLY: Oh, it could go awhile.

23 CHAIRMAN BECHHOEFER: Why don't we have a lunch
24 break for an hour. Make sure...

25 JUDGE COLE: 12:30?

1 MR. DAMBLY: 12:30.

2 CHAIRMAN BECHHOEFER: 12:30.

3 [Whereupon the hearing was recessed
4 to resume at the hour of 12:30 p.m.]

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A F T E R N O O N S E S S I O N

CHAIRMAN BECHHOEFER: Okay. Back on the record.
Staff.

MR. DAMBLY: Yes. We might have a few questions.

CROSS-EXAMINATION

BY MR. DAMBLY:

Q Yesterday, Ms. Berger, do you recall testifying
that back in the '80's you worked at a DOE contractor under
an order that required you to use compartment factors?

MR. BROOKS: Objection. That's not what she
testified to. But go ahead. I'm sorry.

THE WITNESS: I worked for a DOE contractor that
was required by DOE order to apply the ICRP 26 weighting
factors for assessments of effective dose equivalent.

BY MR. DAMBLY:

Q How about compartment factors?

A Not, you mean, compartment factors like in the
ANSI standard, no. There was no specific requirement for
the use of compartment factors.

Q So when Judge Kelber said you said using
compartment factors, and you said compartment factors, you
didn't really mean compartment factors?

A I'm sorry. Say that again.

Q Well, let me quote. Yesterday, at page 1051 of

1 the transcript, does your expertise in the area of
2 dosimetry therefore include expertise in weighting factors,
3 the use of weighting factors. Answer. Yes, back, I want
4 to say it was in the early '80's, but I'm not really sure
5 of the date, the Department of Energy. I worked for a
6 Department of Energy contractor. Excuse me. Had an order
7 that required you to use the ICRP 26 organ weighting
8 factors for all dose assessments, internal, external and
9 uniform and non-uniform exposures.

10 So back at my place of work at that time we did
11 quite a number of external dose assessment using
12 compartment factors. You said using compartment factors.
13 The witness, I'm sorry, that was Judge Kelber. The
14 witness. Compartment factors.

15 A Yes, that's correct.

16 Q The order didn't require the use of those?

17 A No. The order didn't. The order required the
18 use of the ICRP 26 weighting factors. We developed the
19 compartment factors in order to compare our calculated
20 doses to the dose limit that was in the order.

21 Q To your knowledge, has any federal agency adopted
22 specifically by rule or regulation the use of weighting
23 factors and compartment factors for the calculation of
24 external doses?

25 A Weighting factors, because there's no distinction

1 between internal and external dose, but specific
2 compartment factors, to my knowledge, no federal agency has
3 adopted them by rule. They appear in position papers and
4 things.

5 JUDGE COLE: I'm sorry. I didn't hear the last
6 part of that.

7 THE WITNESS: They appear in like a position
8 papers, I've seen them. To my knowledge there's no rule.

9 BY MR. DAMBLY:

10 Q There is no rule adopting the use of weighting
11 factors for external?

12 A No. That explicit designates compartment
13 factors. There are federal rules that require the use of
14 organ weighting factors for the assessment of internal
15 dose. Excuse me, internal and external dose. They're not
16 explicit. There's no distinction between the two.

17 Q There's no distinction. What agency are you
18 talking about?

19 A 10 C.F.R. Part 20. If you read the definition of
20 weighting factors, it does not discern between the internal
21 and external dose. It simply says when you are estimating
22 the dose from non-uniform exposure of the body, then you
23 use these weighting factors to come up with the dose
24 equivalent.

25 Q Where does it say that?

1 A I hope I didn't paraphrase the agency out of
2 context. Weighting factor for an organ or tissue is the
3 proportion of the risk of stochastic effects resulting from
4 irradiation of that organ or tissue to the total risk of
5 stochastic effects when the whole body is irradiated
6 uniformly.

7 It doesn't distinguish whether that radiation
8 comes from inside, upside or outside of the body.

9 Q Excuse me. You are familiar with the infamous
10 footnote in this case, are you not?

11 A Yes.

12 Q And you're also aware that ICRP 26 does not have
13 a factor for whole body as a weighting factor. It only
14 lists whatever it is above whole body in the NRC
15 regulations.

16 A That's because the application --

17 Q My question wasn't why that is. Is it true?

18 A Is it true that ICRP 26 does not have a whole
19 body factor?

20 MR. BROOKS: Your Honor, I'm wondering if, I
21 don't have any question to Mr. Dambly getting his question
22 answered, but I'm wondering if the witness could be
23 permitted to complete her answer before he asks his next
24 question.

25 CHAIRMAN BECHHOEFER: Permitted. Finish her

1 answer.

2 MR. DAMBLY: I was only asking a very simple yes
3 or no question. It didn't call for an explanation. The
4 question was very simply does ICRP 26 have a weighting
5 factor for whole body. I didn't ask her why or why not. I
6 asked a question. I'm entitled to an answer to my
7 question.

8 CHAIRMAN BECHHOEFER: Occasionally yes or no does
9 not provide an adequate answer for the record at least.

10 MR. DAMBLY: I can't possibly see how that would
11 be inadequate.

12 CHAIRMAN BECHHOEFER: Well, anyway. Go ahead.

13 BY MR. DAMBLY:

14 Q It is true that ICRP 26 does not have a whole
15 body weighting factor?

16 A It does not specific whole body, but when you add
17 up all of the weighting factors for irradiation of all of
18 the organs, you get a whole body weighting factor of one.

19 Q And does ICRP 26 have a footnote that says for
20 the purpose of weighting the external whole body dose, a
21 single weighting factor of one has been specified?

22 A ICRP 26 does not distinguish between internal and
23 external dose. It does not have such a footnote. The
24 answer is no. I'm sorry.

25 Q And so the NRC does distinguish between internal

1 and external?

2 A This footnote implies a distinction, yes, it
3 does.

4 Q Have you ever done and submitted for a licensee
5 at the NRC an external whole body dose calculation, a TEDE
6 calculation if you will, under the regulations using a
7 weighting factor other than one?

8 A My company is not an NRC licensee, so I've never
9 made a submission to the NRC.

10 Q I said for an NRC licensee.

11 A Oh, I'm sorry. Using a weighting factor other
12 than one?

13 Q Right.

14 A No. I've never done that for submission for a
15 regulatory agency. The answer is no.

16 Q And in point of fact, the report that you have,
17 which is Exhibit 14, you were very careful to express your
18 results as effective dose equivalent, not TEDE, is that
19 correct?

20 A That's correct. It was an effective dose
21 equivalent in compliance with the ICRP 26 methodology, but
22 because compartment factors were used, I assumed that there
23 would be some approval involved before the dose of record
24 that the licensee would record would be in units of TEDE.

25 Q What were you asked to provide to Mr. Slack?

1 A Simply an assessment of the dose that
2 Mr. Chastain may have incurred. That was all.

3 Q Did he ask you for an assessment under the NRC
4 regulation?

5 A No, he did not. I don't want to lead you astray
6 on that. He did not ask for an assessment under the NRC
7 regulations, but he said he wanted to know if the body dose
8 was above the NRC dose limit. That was the question that
9 he asked me.

10 Q Well, did you assume that you were working under
11 the NRC regulations?

12 A I believe he told me that this involved an NRC
13 license.

14 Q Did you do your calculations in accordance with
15 your understanding of the NRC regulations?

16 A I did. I did my calculations in accordance with
17 my understanding of the regulations and the fundamental
18 principles behind it. And with the footnotes that were
19 there as well.

20 Q And you're aware, as we've said, the footnote
21 specifies a one for external whole body dose weighting
22 factor?

23 A It specifies that when there's no just -- let me
24 back up a second. It's my interpretation that it specifies
25 that when there is no need to apply a weighting factor. If

1 there is a need to apply a weighting factor, then I would
2 imagine that's when it needs to be submitted on a
3 case-by-case basis for approval.

4 Q From your experience, you have knowledge of the
5 regulations, are changes, permissions to deviate, whatever
6 you will, granted normally after an accident has occurred
7 in a violation issue?

8 A I guess that was kind of a global question. Say
9 that again. Changes to what? To weighting factors?
10 Pardon me?

11 Q You have knowledge of the regulations and how
12 they came about and whatever. And you've testified a lot
13 about NRC's regulations, their intent and what NRC does.
14 To your knowledge, would it be a normal situation for the
15 NRC to grant we'll call it an exception, a permission or a
16 whatever to deviate from its regulations after an incident
17 has occurred and a violation has been issued?

18 A I --

19 Q You don't know?

20 A I don't know the answer to that, no.

21 Q Okay. Now, you also said earlier today, in fact
22 more than once I'm sure, that ICRP 26 does not distinguish
23 between accidental unexpected exposures and any other
24 normal exposure, is that correct?

25 A For the purposes of using the weighting factor,

1 that's correct.

2 Q Let me draw your attention to Exhibit 26, please,
3 which should be in front of you. If you'd turn to page 33,
4 please. On page 33, is everybody on page 33 of Exhibit 26?
5 If I could call your attention, does paragraph 183, the
6 first three sentences, read as follows. In accidents or
7 suspected accidents, more detailed information should be
8 sought when the distribution of absorbed dose, dose
9 equivalent or contamination. An estimate should be made of
10 the average dose equivalent over a one square centimeter in
11 the region of the highest dose equivalent. This dose
12 equivalent should then be compared with the dose equivalent
13 limit. Does it read that way?

14 A Yes, it does.

15 Q Thank you. Now, let's go to your report. And,
16 I'm sorry. Before we do that, you did make an interesting
17 comment this morning. You said when you were using at DOE
18 between '86 and '91 or whatever, if I wrote the dates
19 right, doing these compartmental dose calculations,
20 compartmented, compartmental, I don't know. Anyway, you
21 weren't doing them on a case-by-case basis but on a
22 person-by-person basis.

23 A Yes, that's correct.

24 Q So you distinguished between a case and a person?

25 A I meant to imply that I didn't globally apply the

1 same compartment factor to every individual. That it was
2 an individual specific compartment factor.

3 Q Now, the first thing I would like to call your
4 attention on your report is that, first, tell me exactly
5 from your report, reviewing it, whatever helps you,
6 apparently they enjoyed the question. Exactly what
7 documentation you had in front of you when you did your
8 calculations of the various scenarios and how you used that
9 information.

10 A That report was in here, isn't it?

11 Q It's, I'm sorry, number 14.

12 A Okay. On page one and two, there's a list of
13 documents with bullets. That was the information that was
14 provided to me.

15 Q Okay. And I'm sorry. Excuse me for backing up a
16 little bit, because I forgot one other area I didn't want
17 to go over with you. If you would turn to Exhibit 24. We
18 can get that out of the way. The ANSI standard for, I
19 guess, HBS N13.41-1997.

20 A Right.

21 Q And you were one of the co-authors of that
22 report, is that correct?

23 A Yes. The working committee draft.

24 Q Pardon?

25 A Yes. I was one of the authors of the working

1 committee draft.

2 Q And the name of that standard is Criteria for
3 Performing Multiple Dosimetry?

4 A That's correct.

5 Q And multiple dosimetry is defined on page eight
6 of the standard as the practice of placing more than one
7 dosimeter on an individual's body to determine the doses at
8 various regions of the torso, head, arms and legs. Is that
9 correct?

10 A I'm sorry. Say that again.

11 Q Page eight.

12 A Okay. All right. I'm ready. Go ahead.

13 Q Over there where we have, quote, multiple
14 dosimetry, unquote, is the practice of placing more than
15 one dosimeter on an individual's body to determine the
16 doses at various regions of the torso, head, arms and legs.

17 A That's correct.

18 Q And you're aware this case, Mr. Chastain had but
19 one dosimeter.

20 A Absolutely, yes. There was only one dosimeter.

21 Q Under scope, which is on page nine, the standard
22 neither requires nor prohibits the use of multiple
23 dosimeters for external dosimetry purposes. Since the
24 choice of multiple dosimeters rather than use of a single
25 dosimeter selectively placed on the body to determine the

1 dose is left to the professional judgment of radiation
2 protection professionals. However, once their use has been
3 deemed appropriate, this standard contains criteria
4 applicable to routine occupational activities for when and
5 how to use multiple dosimeters, et cetera. Is that
6 correct?

7 A That's correct.

8 Q And you're also aware under the scope, in the
9 next paragraph below that, sudden or unexpected changes in
10 the radiation environment as might occur during accidents
11 are beyond the scope of this standard.

12 A Yes. This standard does not contain guidance on
13 what to do if you find out that the exposure conditions
14 have changed after you've already made the dosimeter
15 assignment. It doesn't go that far.

16 Q As you mentioned this morning, but dosimeters,
17 badges on each of your shoulders and the source got dropped
18 and those weren't the part that were closest to the --

19 A That's correct.

20 Q It would be inappropriate?

21 A It would be inappropriate. You're working with
22 something that is creating a non-uniform exposure and
23 you've planned for a non-uniform exposure at the chest, and
24 all of a sudden it changed to the feet or the knees or
25 something like that.

1 Q As you just said?

2 A Yes.

3 Q Use of multiple dosimeters, correct use of
4 multiple dosimeters requires planning?

5 A Requires job pre-planning to be able to use the
6 multiple dosimeters to assess the dose to the compartments.
7 That's exactly correct.

8 Q And one doesn't normally plan to have an accident
9 when you're a radiographer?

10 A I don't think one ever plans to have an accident.
11 They just happen.

12 Q Thank you. Now, we'll get back to your report.
13 I'm sorry. Now, your first conversation with Mr. Slack,
14 what did he tell you happened? The thing that you've been
15 describing, the scenario, I guess, or your first case at
16 any rate. What exactly did he tell you?

17 A What he had told me is that a radiographer had
18 climbed a ladder and determined that the source was not
19 fully retracted. And he climbed back down the ladder,
20 found that his self-reading dosimeter was off scale.
21 However, his alarming dosimeter did not alarm. He told me
22 that Conam processed the film badge that was in the same
23 location as those two devices and got a radiation dose of
24 4.6 REM.

25 Q Okay. And from that you made a reconstruction

1 yourself in your mind?

2 A Well, I had kind of a general picture. I then
3 went on and asked him questions. The same things I think
4 probably the NRC did in theirs. They said, well, how far
5 up the ladder was he? How big is he? How tall is he?
6 What's the length of his legs? What's the distances, did
7 you have that information?

8 Q Did you write that down anywhere what he told
9 you?

10 A He sent me. When I told him that kinds of
11 information that I wanted, and it's common information
12 you'd ask for in a dose reconstruction, he sent me what he
13 had. And this is the list of information that he sent me.

14 Q Okay. And so in terms of the measurements, if I
15 understood you correctly, you took those from?

16 A Yeah. The NRC's measurements were really the
17 only ones that were in the package that I could use.

18 Q And that's what the, it's not 10, was it 11?

19 A I had it listed down here as Conam Inspection,
20 Inc. dose reconstruction data. At this time I didn't know
21 that was an NRC document. I guessed because it was the
22 same type as the inspection report.

23 Q If you look at it on, I believe, you testified on
24 Exhibit 11 in that book, that is the document?

25 A That's it. Yes. That's correct.

1 Q And you did indicate in point of fact Mr. Young
2 and Mr. West and Mr. Phillips of the NRC were there?

3 A That's why I put in there NRC. I'd assumed
4 that's who it was, but it didn't clearly say it on the
5 document.

6 Q But this document does not have, which you've
7 later seen, I take it, that was in the full reconstruction,
8 which is the document in front of that, 10, the diagram.
9 As you indicated this morning?

10 A Right. Yes. That was, when you read things that
11 are like in document, excuse me, Exhibit No. 11. I heard
12 Mr. Slack. I did form a picture in my mind. And I
13 pictured the device to be smaller and I pictured it to be
14 pointed directly at his leg.

15 Q Okay. Now, that was going to be -- if you would
16 turn to Exhibits 21 and 22. And I will represent to you,
17 based on what's been admitted in the record, Exhibits 21
18 and 22 were taken on the day of the accident by Conam,
19 clearly in their possession in February of 1996. When was
20 the first time you saw those?

21 A I saw those at the dose reconstruction or
22 reenactment that was done at Eli Lilly in August of '98.

23 Q Okay. Just so it's clear, because that's where I
24 thought I heard this morning you just said. And maybe the
25 best way to do that, well, looking at the picture you have

1 in front of you, let's look at Exhibit 21. Where did you
2 position the camera and the individual?

3 A For the dose assessment that I had done?

4 Q The dose assessments that you did. Not the
5 reconstruction. We'll talk about those, too.

6 A Okay. Well, I had an individual, in my mind,
7 climbing a ladder such that the device here where the
8 yellow cord, the guide tube was coming out, it was pointing
9 at the individual. The device was small enough to be able
10 to point forward directly at him.

11 Q It was pointing, as he climbed the ladder, the
12 center line of the device was pointed at the center line of
13 his body?

14 A Yeah. You see how that one is sitting there now,
15 it's almost parallel to the top of the ladder? It was
16 perpendicular.

17 Q Perpendicular. So then basically your
18 calculations assume a factual scenario which does not in
19 any way, shape or form comport with the actual facts of
20 this case?

21 A I'm not really sure we still know what the actual
22 facts of this case. We've got two or three different
23 scenarios that we're looking at. And I'm just not sure we
24 have the actual facts, and I'm hesitant to pick apart
25 subtle details. I don't think it will gain us anything in

1 this case.

2 Q I'm not talking about the subtle details, of
3 which way he was turned and when he was turned. I'm
4 talking, this is not a subtle detail facing the exit port
5 of the camera as opposed to being alongside?

6 A That's correct. And if I stop and think back
7 about that now, if I didn't know the difference between the
8 two, if I didn't know whether it was pointed forward or
9 pointed off to the side, I probably still would have
10 elected to have done the dose reconstruction with it
11 pointing forward, because I would have calculated a higher
12 dose.

13 MR. DAMBLY: Well, I mean, at this point I'd like
14 to actually ask that Exhibit 14 be withdrawn and stricken
15 from the record because it does not represent anything.
16 This is an evidentiary hearing. All decisions must be
17 based on facts in the record. By the witness's own
18 testimony, this does not comport with any scenario that
19 anybody has testified to whatsoever. It makes it totally
20 irrelevant for consideration in this hearing.

21 MR. BROOKS: I guess I'd say two things. One, it
22 would be a little surprising for the staff to ask that the
23 document that forms the basis for their assertion of a
24 violation be stricken from the record. If it's stricken
25 from the record, then I would suggest that the panel or the

1 Board could find now that there's no violation since that
2 is the document that the staff says they're relying on.

3 Secondly, I think that given the varying degree
4 of testimony about where Mr. Chastain was, we don't know
5 whether he was inside or outside the colonnaded beam coming
6 out of the front of the camera, which is the assumption
7 that Mr. Dambly is questioning the witness on right now.

8 If one were to conclude from the record that
9 we've heard that Mr. Chastain was at some time within a
10 collimated beam, then I believe that the witness's
11 testimony is that her calculations would be entirely
12 accurate and the best record. If one concludes that Mr.
13 Chastain was outside the colonnaded beam, then I think that
14 Mr. Dambly's questions are right on point. I think the
15 witness testified to that possibility.

16 So I think we've got appropriate cross-
17 examination that has focused on the possibility that he may
18 not have been within a collimated beam. It's a perfectly
19 legitimate question. Does it invalidate the report? Not
20 at all, because we don't know the answer to whether that
21 assumption was true or not.

22 MR. DAMBLY: You know, again, I beg to differ.
23 The first place, whether anybody knows for sure whether or
24 not, and for that matter, I don't even know to this date
25 whether Mr. Chastain knows where he was. And in point of

1 fact he has posited one or two or three different
2 scenarios, none of them, and there's nobody with
3 uncontroverted evidence of record. The camera was not
4 facing perpendicular to the ladder and he did not go up and
5 down the ladder right in directly into the highly
6 collimated beam. We don't have that anywhere.

7 Now we have a document here and to address what
8 he said previously, the cover letter to the NOV happens to
9 say, hey, even if we accept yours without the weighting
10 factors, we get a number that's a violation. However, the
11 NOV itself says, contrary to the above the licensee did not
12 limit the annual occupational dose in adult radiography to
13 five REMs total effective dose equivalent. Specifically
14 the individual received a radiation dose of a minimum of
15 six REMs total effective dose equivalent, which is the
16 figure coming out of Mr. West's report, not the licensee's
17 reenactment. So I'd like to have the entire thing
18 stricken. It's clearly not relevant. It's not based on
19 facts and you can't consider a document not based on facts
20 of record in this case.

21 CHAIRMAN BECHHOEFER: The Board will deny the
22 motion. It's our belief that there's no dose estimate that
23 is based on uncontroverted fact of anyone. So we would
24 like for --

25 MR. DAMBLY: Excuse me. I'm not asking for

1 uncontroverted facts. I'm talking about facts in the
2 record. It must be based on one factual scenario that has
3 been presented before this Board by testimony. There is no
4 testimony whatsoever that there was a camera facing
5 perpendicular to the ladder and that the individual went
6 straight up and down.

7 You have no testimony to back that up and you
8 cannot accept a document for which that is the sole
9 premise.

10 CHAIRMAN BECHHOEFER: Well, be that as it may,
11 we're accepting it. We'll evaluate it. We'll decide what
12 weight it deserves.

13 JUDGE COLE: Mr. Dambly, I think the angle of the
14 camera is a question here. And we can visualize scenarios
15 whereby a man going up the right side of the ladder might
16 have his leg directly in that path just as the scenario
17 posed by the witness.

18 MR. DAMBLY: The problem with that, Your Honor,
19 you have to have the entire scenario. You may posit,
20 although there was no testimony his right leg was there,
21 you can't posit his film badge directly in front of that
22 camera. There's no testimony from which you can draw that
23 conclusion and that's central to the report that you have
24 in front of you. It is improper to consider non-factual
25 data in an evidentiary hearing.

1 We're not here for hypotheticals. Maybe he
2 walked in front of it. Maybe he left his film badge there
3 yesterday and picked it up the next day. You can't
4 consider those because we don't have any evidence of those
5 in the record.

6 JUDGE KELBER: Mr. Dambly, does the other --
7 we've been offered two doses at the reconstructions. Does
8 the other dose, this one and the one prepared by Mr. West.

9 MR. DAMBLY: Yes.

10 JUDGE KELBER: Does that rely on facts not in
11 evidence?

12 MR. DAMBLY: I do not believe so. As you were
13 told, they took measurements with Mr. Chastain. He stood
14 there. They took his measurements and from those
15 measurements they did a calculation.

16 JUDGE KELBER: Did they attempt to determine
17 where in the labrynth of the shield the source pellet was?

18 MR. DAMBLY: I believe you had testimony that was
19 the case. And I believe also -- you can disagree --

20 JUDGE KELBER: I don't believe that is the case.

21 MR. WEST: Sir, I believe I testified to that and
22 we can check the transcript, but I believe I testified to
23 exactly that.

24 JUDGE KELBER: You do not satisfy me that you did
25 a calculation in which you moved the source pellet along

1 various points of the labrynth.

2 MR. DAMBLY: And again, there is no testimony in
3 this case that the source pellet moved.

4 JUDGE KELBER: Yes. There's testimony that has
5 been introduced that it was somewhere between the one-half
6 turn and the one-third turn position. Where it is, and
7 that makes a difference, and where the source pellet is in
8 the labrynth, it makes an enormous difference.

9 MR. DAMBLY: Not in the way the staff did. I'm
10 talking about factual basis. They have a factual basis.
11 They took measurements of a scenario that Mr. Chastain
12 proposed. He did not posit at any time the scenario for
13 which all the reconstructions here were done.

14 JUDGE KELBER: But he did posit that it was
15 either a one-third or one-half turn. The only calculation
16 which makes any allowance for the possibility that it was
17 at some position between the one-half turn and the
18 one-third turn is the one in question. That's the only one
19 we have which addresses that theory.

20 MR. DAMBLY: Now, I believe you heard ad nauseam
21 from Mr. West based on your questions and otherwise that
22 that's taken into account by the fact that the staff did
23 not assume a source strength and then work backwards.

24 JUDGE KELBER: Let's assume that. And I will
25 tell you that there will be an opinion, a technical

1 opinion, by an internationally known expert that that is
2 shear nonsense. This is a labrynth shield problem.

3 MR. DAMBLY: And I would move to strike that
4 because you're not a witness in this case.

5 JUDGE KELBER: Okay. But I can assure you
6 that --

7 MR. DAMBLY: You can't testify.

8 JUDGE KELBER: I will not testify. I will write
9 an opinion citing sources that tell you that it is not a
10 useful way of assessment of a labrynth shield. So in that
11 case we will be without any dose reconstruction. I think
12 you ought to reconsider.

13 CHAIRMAN BECHHOEFER: We're denying the motion.
14 The Board is denying the motion. Let's go from there.

15 MR. DAMBLY: I would like the grounds stated
16 again, please.

17 CHAIRMAN BECHHOEFER: Well, you have heard over
18 the last couple minutes why.

19 MR. DAMBLY: I've heard Dr. Kelber say he's got a
20 different technical opinion, but I'd like to know the
21 grounds on which, the legal grounds on which the objection
22 is being overruled.

23 CHAIRMAN BECHHOEFER: The legal ground is that
24 this is the basis for an expert opinion and to the extent
25 that the ingredients are shown to be not accurate, we will

1 take that into account in evaluating what weight should be
2 given to the particular document. This does not affect its
3 admissibility.

4 BY MR. DAMBLY:

5 Q Ms. Berger, did your shielding assumptions, would
6 they be valid for a situation in which in point of fact the
7 badge was shielded from the camera and not in the highly
8 collimated beam?

9 A My dose reconstruction, I did not have the badge
10 directly in the line of sight of the beam. It was the lead
11 that was in the line of sight of the beam.

12 Q So it went between the shielding?

13 A So the badge went between the shielding. That is
14 correct.

15 Q The shielding depleted uranium?

16 A Yes, it did.

17 Q Where is that in the calculation?

18 A Where was that? That was 14.

19 MR. BROOKS: Exhibit 14.

20 MR. DAMBLY: Pardon?

21 MR. BROOKS: I'm just trying to help the witness
22 find the exhibit that you were asking about.

23 MR. DAMBLY: Oh, I'm sorry. I thought you said
24 page 14.

25 THE WITNESS: If you look at, and I'm going to

1 probably have to apologize again for this page numbering,
2 but it's on page nine, up at the very top are the
3 assumptions for the calculation of the dose rate at the
4 point where the badge was. And if you look down at the
5 one, two, three, four, fifth bullet. It says a beam of
6 ionizing radiation from the shield source of the camera
7 traverses 1.3 centimeters of air within the source to .87
8 centimeters of titanium, 1.38 centimeters of foam, .56
9 centimeters of steel and 33.6 centimeters of air prior to
10 reaching the front of the subject's dosimeter.

11 BY MR. DAMBLY:

12 Q And my question was, where is the depleted
13 uranium in there?

14 A Oh, I'm sorry. You're right. When it's going
15 up, it was -- I'll have to go and look at the actual
16 numbers, but you're right. That angle at that point may
17 not have included depleted uranium. You're correct. I
18 misspoke.

19 Q And did you include, as you testified earlier --
20 I really wish we could move to the other hearing room.
21 But as you testified earlier, the source is encapsulated in
22 a steel capsule?

23 A Yes, that's correct.

24 Q You said you took into account, first, that it
25 passed through the steel capsule?

1 A Yes.

2 Q Where is that?

3 A That is the first --

4 Q The first thing I see is 1.23 centimeters of air.

5 A Yeah. There is a -- go back to make sure that I
6 have the right one here. This is giving a summary of
7 information here, but the -- okay. You've pointed out a
8 discrepancy.

9 Q So did you get that on the record?

10 CHAIRMAN BECHHOEFER: What did she say?

11 JUDGE KELBER: She said he pointed out a
12 discrepancy.

13 BY MR. DAMBLY:

14 Q So then it's possible both that you did not take
15 into account the depleted uranium and you did not take into
16 account the steel casing on the source?

17 A I would have to go back and look at my hand
18 calculations where I figured out the angles of incidence.
19 I may have just not translated them until this letter. I
20 just don't know the answer to that.

21 Q You did hand calculations on the sheet?

22 A To determine the distances and the thicknesses of
23 the shielding, yes.

24 Q And you based those on what?

25 A I based those on the measurements that were given

1 in the NRC measurements.

2 Q The shielding wasn't mentioned in the NRC
3 measurements.

4 A Oh, yes, I'm sorry. That was on the, let's see,
5 there was a drawing. Here it is. If you look on page two,
6 one, two, three, fourth bullet up from the bottom, there
7 was a report that was sent to Bob Slack from Kate Roughan
8 at Amersham Corporation which was a drawing of that device
9 that showed the shielding layers and the distances.

10 MR. DAMBLY: Judge, go ahead.

11 JUDGE COLE: Ms. Berger, I'm looking at footnote
12 23.

13 THE WITNESS: Yes.

14 JUDGE COLE: And there it mentions 2.97
15 centimeters of depleted uranium. Could it be that in your
16 summary at the top you just didn't list it but did in fact
17 include it?

18 THE WITNESS: I don't know the answer to that
19 without studying it for a moment. I apologize.

20 MR. BROOKS: Look at the footnote, would you?

21 MR. DAMBLY: Could you -- I don't see a footnote.
22 Where is footnote 23? I'm sorry.

23 JUDGE COLE: Footnote 23 on page nine.

24 MR. BROOKS: That explains the difference. It's
25 the difference between a third of a turn and a half of a

1 turn.

2 MR. DAMBLY: She used the half turn.

3 THE WITNESS: Thank you. Yes.

4 BY MR. DAMBLY:

5 Q Yes, what? Yes to what?

6 A When you move the device back to a third of a
7 turn, of course you're going to penetrate through the
8 depleted uranium layer where, when you get out at a half
9 turn, at the angle where the badge was supposedly residing,
10 you do not pass through the depleted uranium layer at that
11 point.

12 Q You're positive?

13 A That was the calculation that I had done.

14 Q Do you have those calculations or those hand
15 calculations and measurements you made?

16 A Here? No, I do not. I have a copy of the
17 drawing of the fax. I have the fax that was sent to me by
18 Bob Slack.

19 Q Do you have that?

20 A Yes, I do.

21 Q Do you have with you then also the thing I was
22 curious about yesterday with Mr. Slack, the next to the
23 last bullet on page two, written communication to Carol
24 Berger from Robert Slack, Conam Inspection Mock-Up
25 Exposure?

1 A Yes, I do have that with me.

2 Q Could you provide that to me, please?

3 MR. BROOKS: Do you want it now?

4 MR. DAMBLY: I'd like to review that document,
5 please.

6 MR. BROOKS: If the Board wants to get into that,
7 that's fine.

8 MR. DAMBLY: I'd like to. I'm entitled to know
9 the basis on which she made her calculations and the
10 information she was using.

11 CHAIRMAN BECHHOEFER: Yeah. I believe we should
12 do that.

13 MR. BROOKS: Fine.

14 [Short pause.]

15 MR. DAMBLY: Thank you. If I may have just a
16 moment, Your Honor?

17 [Short pause.]

18 MR. DAMBLY: Now that I see this, I have some
19 questions and maybe it would be worthwhile to get a copy
20 made for the Board as well, because I see scenario 1
21 involves 30 curies and five dosimeters. So I'm kind of at
22 a loss as to what we're talking about here.

23 MR. BROOKS: Why don't you first show her the
24 documents and ask her if they played any part in her
25 calculations. That might be.

1 BY MR. DAMBLY:

2 Q The November 26, 1997 letter to you from
3 Mr. Slack, tell me what that is?

4 A After we had our first discussion, Mr. slack sent
5 me some information that he thought might help answer some
6 of the questions that I had. And this is just a collection
7 of some of those things. Included in it, Mr. Slack had
8 told me, or maybe I had asked him if he had taken a camera
9 similar to that and tried to come up with exposure rates at
10 various distances, and he said he did. And he sent me
11 these data.

12 I used this to give me sort of a general idea
13 what kinds of dose rates were coming out of the device. It
14 was just mostly just for qualitative purposes. This didn't
15 enter into the dose calculations at all.

16 Q It didn't enter into the dose calculations at
17 all?

18 A No.

19 Q And the rest of the documents that's in here, I
20 guess, for the most part are already in the record?

21 A I don't know that, but we can certainly check.

22 Q Was this the only submission you had from Conam
23 of written documentation on this?

24 A No. Everything that's on this list is what they
25 had sent to me. There was some other things that came

1 after that one. That was the first one I received.

2 Q Now, if I understand correctly, is this the
3 diagram, and I'll show you, is that the diagram on which
4 you based your measurements?

5 A No, it's not.

6 Q Oh, it's a different document.

7 A Yes. It was a fax communication from Kate
8 Roughan at Amersham to Bob Slack.

9 Q Okay. And on that does it indicate how far
10 before the exit port the depleted uranium ends?

11 A Yes, it does. It gives specific measurements.

12 Q Do you know what those were?

13 A No, but I can look it up.

14 Q Well, if you'd go ahead and take a look, I'd
15 appreciate that.

16 MR. BROOKS: I guess I'd object at this point.
17 We're going to be going back to other documents. Her
18 report is what it is. She says what she relied on. If the
19 Board wants to see those documents, that's fine with me,
20 but I'm just not sure that we're in useful territory.

21 MR. DAMBLY: I'd like to know the basis on which
22 she decided not to put the depleted uranium in the shield.
23 And we do have it here.

24 JUDGE COLE: I thought she answered that
25 question, Mr. Dambly, by saying that the angle did not pass

1 through the uranium.

2 MR. DAMBLY: No, I appreciate that the angle did
3 not pass through according to what she said.

4 JUDGE COLE: Right.

5 MR. DAMBLY: But I know that the pelvis backwards
6 is, according to their measurements, was what, two inches
7 or more in? I'm sorry. Is an inch inside the exit port.
8 But I guess, and according to her measurement, a half an
9 inch from the end of the shield. So your testimony is the
10 angle that you assumed?

11 THE WITNESS: For the first scenario, using the
12 distance given in the NRC report.

13 MS. JONES: Speak up.

14 THE WITNESS: Sorry. Using the distances given
15 in the NRC report, you've got a line of sight from the
16 source directly out to his thigh, but then it comes up a
17 little bit to get to his, what you call it, the little pack
18 thing that he wore where the film badge was.

19 BY MR. DAMBLY:

20 Q Well, I'm curious. I mean, I appreciate that in
21 the NRC report it's that, but in what you got was just
22 figures?

23 A Yeah. I just literally drew lines and did a few
24 tangents and co-signs, and, you know, X-squared plus
25 Y-squared equals E-squared to figure out thicknesses of

1 shield through there. I didn't, actually I made some
2 simplifying assumptions. Can I draw a picture? Maybe that
3 would be helpful.

4 Q If that would help you and it would help us, I'd
5 be glad to see pictures.

6 A I just don't, you know, I'm afraid that --

7 Q And while you're doing that, how far, did you
8 assume that the exit port was even with the top of the step
9 ladder or was it sitting out over the ladder, or where?

10 A I didn't think about the ladder. I only used the
11 distance that the NRC measured from the device to his leg.

12 Q Okay.

13 A I believe it was ten inches. That was it. I
14 didn't think about the ladder. I'm not a good drawer.

15 Q We'll be the judge of that.

16 A This up here is the depleted uranium. This level
17 right here --

18 MR. BROOKS: You might have to --

19 THE WITNESS: I'm just not a good drawer. Can I
20 just take a picture that I made. You can see it on the
21 picture.

22 MR. BROOKS: Sure. If that would help.

23 [Short pause.]

24 MR. BROOKS: Is this picture that you're
25 referring?

1 THE WITNESS: Yeah. That's the one. This is the
2 one. Here. I used.

3 BY MR. DAMBLY:

4 Q Did you assume that was the drawing that's to
5 scale?

6 A Yes, I did. They gave distances and thicknesses
7 in here, .55 inches was the outside diameter of the
8 titanium. And I think they gave some inches here. And I
9 assumed it was to scale, yes.

10 JUDGE COLE: So what you're looking at is a
11 picture of the cross-section of the radiographic device?

12 THE WITNESS: Yes.

13 JUDGE COLE: That would give us an indication on
14 how you arrived at your conclusion of the material that the
15 rate it passed through and went to the film badge?

16 THE WITNESS: Right. That's correct.

17 BY MR. DAMBLY:

18 Q Well, then you're familiar with the size of the
19 paper that this is on? Is this an 8-1/2 by 11 sheet of
20 paper?

21 A Yes.

22 Q And the dimensions across the bottom from the
23 front to the back says 12-7/8 inches?

24 A Yes.

25 Q Can you have a to scale drawing at that scale?

1 A Oh, I'm sorry. I didn't mean that this drawing
2 is exactly to scale. I mean that it's not full scale is
3 what I meant.

4 Q What did you assume the scale was?

5 A They gave some dimensions here. And I used those
6 as the guide for the dimensions throughout.

7 Q So you did a reduction?

8 A That's correct. Yes.

9 Q Who told you this was a to scale drawing?

10 A I just assumed it was because from here to here
11 didn't look like 12-7/8 inches to me. It looks like that
12 it was a lot smaller.

13 Q Did you take your scale and verify it with all
14 the dimensions on there?

15 A I did with all the dimensions that were on there
16 that they were.

17 Q You don't know for a fact?

18 A No, I sure don't.

19 Q Okay. With reference to that and whatever scale
20 you thought that was, where did you assume the film badge
21 was?

22 A Can I look at the NRC report here?

23 Q Sure.

24 A We have the source sitting at, well, I don't know
25 if it was the one-half turn or the one-third turn, but

1 let's just assume that it's sitting right here for a
2 second.

3 Q But your ultimate calculation was based on the
4 one-half turn?

5 A On the one-half turn, yeah. And so let's assume
6 it's sitting right there. I'm just pointing at that now.
7 I think that this -- if the source was sitting right there,
8 the distance to his thigh would have been 10 inches. And
9 then the distance to his film badge would have been 13
10 inches going up higher.

11 Q And you plotted all this out and basically you
12 employed a depleted uranium shield?

13 A No. It included a depleted uranium shield. I
14 apologize. I think that there was a translational error in
15 the bullet that didn't appear. Because if you look at the
16 micro shield summary output, the uranium is there.

17 Q Where in the summary output?

18 A I believe it is, unless I'm mistaken on that as
19 well, too. Let's see, shield five.

20 CHAIRMAN BECHHOEFER: What page?

21 THE WITNESS: I'm sorry. There's no page number.

22 JUDGE COLE: Is it the page immediately
23 following?

24 THE WITNESS: The page immediately following page
25 12, yes.

1 JUDGE COLE: Is this Attachment 1?

2 THE WITNESS: Yes. Let me just make sure that
3 I'm giving him the right. Shield, I'm sorry, shield, I
4 really wish that I had the drawing sheets with me. I
5 apologize. I really am talking about this off the top of
6 my head, and I just can't recall. We can reconstruct that
7 if you want.

8 BY MR. DAMBLY:

9 Q Let me ask you this. Let's turn to where we were
10 going before your bullets, if you will, if I can find them.
11 I guess we were on page nine, correct?

12 A Yes, that's correct.

13 Q And if we look at the second bullet up from the
14 bottom, the one which lists the various shielding that you
15 took into account and we compare that with the page after
16 page 12, you have shield one, 1.22936, and up here you have
17 1.23 centimeters up there. So the first one is there,
18 correct?

19 A The first one is there, correct.

20 Q The second one, you have a .87 and that's the
21 titanium, is that correct?

22 A That's correct.

23 Q And the third one is 1.38 and that's foam?

24 A Right.

25 Q And the fourth one's .56 and that's steel?

1 A That's correct.

2 Q And the fifth one is the 3360 centimeters there,
3 correct?

4 A That's correct.

5 Q So you did not in your calculation, and this
6 appears to be a printout of a calculation, is it not?

7 A Yeah. In this particular one, the depleted
8 uranium shield was not included in that.

9 Q So then your calculation that's the basis of your
10 Scenario A did not include a major factor in the
11 calculation?

12 A I have to go look at the angles here, where that
13 source was located. At that angle up there, it may not
14 have traversed through the depleted uranium shield.

15 Q Do you have that somewhere?

16 A I don't have it with me. I threw those out.

17 Q Otherwise you took into account the depleted
18 uranium, the document doesn't say that?

19 A I spoke without thinking about what I was saying.

20 Q Is that your normal practice as an expert
21 witness?

22 A I am not as precise in my words as I should be.

23 Q Okay. If we could go to page two of your report.

24 JUDGE KELBER: May I interrupt for a minute?

25 MR. DAMBLY: Sure.

1 JUDGE KELBER: Could I see that drawing?

2 MR. DAMBLY: Sure.

3 JUDGE KELBER: Was there performed either for the
4 half turn or the third turn position where the depleted
5 uranium shield did come into play?

6 THE WITNESS: Yes.

7 MR. BROOKS: I'm sorry. Dr. Kelber, I might have
8 missed your question. Was there a calculation where
9 depleted uranium did come into play?

10 JUDGE KELBER: Yes.

11 MR. BROOKS: You're talking about referencing the
12 one that Dr. Cole mentioned in the footnote 23?

13 JUDGE KELBER: Well, any one of them.

14 THE WITNESS: I believe so. I have misspoken
15 again. I believe these were all at the, the ones that are
16 included in here are all at the one-half turn.

17 JUDGE KELBER: And in the one-half turn?

18 THE WITNESS: The source is very close to the end
19 of the device.

20 JUDGE COLE: It's not shielded by the uranium?

21 THE WITNESS: It's not shielded by the uranium.

22 BY MR. DAMBLY:

23 Q If I could follow-up on that then, please. If
24 you look at page two of your report, in the first full
25 paragraph at the bottom there, because the source of

1 Mr. Chastain's exposure was a highly collimated beam of
2 penetrating radiation rather than a uniform irradiation of
3 the whole body, how do you get a highly collimated beam if
4 it's outside the uranium?

5 A To be perfectly honest, the simple fact that the
6 badge on Mr. Chastain read 4.6R told me that probably there
7 was an ambient field associated here.

8 Q That there was a what?

9 A That there was an ambient gamma radiation field.
10 That it was not a pinpoint pencil thin line. If that in
11 fact was the case, then we wouldn't have seen 4.6R on the
12 badge at all if that scenario was a valid scenario.

13 Q Help me understand that. Then it wouldn't have
14 been a highly collimated beam?

15 A That was one of the issues in this dose
16 assessment, is that the assumption that was being made is
17 that it was a non-uniform exposure. And so I made the
18 assumption that the beam was collimated to the point where
19 it was going to irradiate one portion of the body
20 preferentially over other portions of the body.

21 Q But how do you square that with the lack of the
22 depleted uranium shield?

23 A There's an awful lot of things about this dose
24 assessment that I just flat out can't square. I can't
25 address that.

1 JUDGE COLE: Did you use a collimated beam
2 example to get the maximum dose on the legs?

3 THE WITNESS: No. That was a straight shot from
4 the source to the leg.

5 BY MR. DAMBLY:

6 Q And that's because you assumed that the camera
7 was facing directly towards his leg?

8 A Yes.

9 Q It was the exit port in essence, 10 inches,
10 something like that?

11 A Right.

12 Q About a foot away?

13 A I think that that probably accounts for some of
14 the difference between the dose assessment that I had
15 performed in Scenario 2 and the dose assessment that the
16 most likely value that the staff had performed. That came
17 out with 34 REM to the thigh and I calculated 41 or 42, and
18 they're similar.

19 Q At this point, this is as good a point as any,
20 the figures you came up as to whatever scenario you used,
21 for both scenarios you used, and the figures developed by
22 the staff, absent taking weighting factors but applying a
23 weighting factor of one would have reached relatively the
24 same results?

25 A Yeah. They followed similar approaches. There

1 was some simplifying assumptions in both cases, as you can
2 see here, and there's no, in light of the other assumptions
3 that had to go into this dose assessment, I think that they
4 were comparable.

5 JUDGE COLE: So you're saying that your dose
6 assessment, forgetting about weighting factors, your
7 assessment of the dose to the left leg is comparable to
8 what staff found in their calculations using their
9 assumptions?

10 THE WITNESS: Right. Taking into account the
11 fact that I had the leg directly in the center of the beam,
12 where I think that there was some correction for that with
13 the assumption of the isotropic source that the staff had
14 made. But they calculated, I'll have to look, I think it
15 was in the 30's, 30 REM or something to the left thigh, and
16 I calculated 40 REM to the left thigh.

17 BY MR. DAMBLY:

18 Q Now, also if you could turn to page three of your
19 report. You indicate there is one unusual aspect of this
20 case that you cannot readily explain. I'll forgive you for
21 the one, but anyway, I think we might all agree there's a
22 lot of unusual aspects. The subjects, alarming dosimeter
23 warning immediate proximity of the spill during exposure,
24 exposure then could not activate. It was in spite of the
25 fact that the device was declaring to be one, that it was

1 confirmed to alarm at dose rates in excess of 500 MR per
2 hour and that the dose rate at the location of the film
3 badge was between 69,000 and 276,000 MR per hour. Okay.

4 From your calculations, what should be dose at
5 the testimony, the whatever, you accepted 20 MR less, or at
6 20 MR per hour, every place else except in front of that
7 camera?

8 A I made a simplifying assumption that every other
9 compartment received a dose rate was exposed at the rate of
10 20 MR per hour. That was a simplifying assumption, yes.

11 Q Did you use micro shield to test with the pellet
12 half turn down what it should have been at the side of the
13 camera?

14 A No, I did not.

15 Q Why not?

16 A I don't have a good answer for that. I just
17 didn't. I was only interested in the dose to the right
18 thigh and being able to reproduce the dose to the badge.

19 Q And a micro shield would allow you to make that?

20 A Oh, absolutely. We could have made calculations
21 ad nauseam around that device.

22 Q You had a point that you decided to use a
23 simplifying principle or assumption and you didn't check
24 that one out to see if it made any sense at all?

25 A Well, if you'll forgive me for saying this, I'm a

1 consultant to a company that pays me by the hour. And I
2 watch for that kind of thing. I wanted to get a global
3 assessment of the dose. And I could have studied this
4 thing for years. I don't think anyone would have paid me.
5 There's a lot of things.

6 JUDGE COLE: We may be studying it for years.

7 BY MR. DAMBLY:

8 Q You're testifying here as an expert, not as the
9 consultant, is that correct?

10 A Am I testifying here as an expert?

11 Q You're providing us your expert opinion or what
12 you want to tell your client? Which are we getting?

13 A No. I didn't mean to imply that. I meant to say
14 that when I did the dose assessment I was on Conam's
15 payroll and that does have consideration in the amount of
16 study that I will put into a dose assessment like this.

17 Q Would it be fair to say then the first time you
18 got a result that worked out the way you thought it might
19 be useful to them, you quit?

20 A I got a result that I determined was a reasonable
21 representation of dose to the individual in light of the
22 uncertainties associated with the assumptions. We could
23 fine tune them from here to next year and we still don't
24 know exactly how long he stood in any given position. We
25 still don't know his exact distances. We also don't know

1 if when he got off of that ladder, he didn't jump down and
2 twist it a little bit and maybe that picture is not quite.
3 There's a lot of things we just don't know. And there's a
4 limit to how much time and effort and frankly money you
5 want to put into a dose assessment like that.

6 Q I see. The Scenario A, what I'll call your first
7 one, the one that you said you believe is the most likely?

8 A Only because that was when the subject relayed
9 the circumstances that was closer in time to the event.
10 And that was just an assumption on my part.

11 Q I'm glad you rendered that. Your opinion then is
12 it was more likely that when Mr. Chastain reported to his
13 boss on the next day with potential disciplinary action or
14 other things hanging over his head, he was more truthful
15 then than he was to the NRC knowing under the regs
16 everything else, with the ladder, with the camera, that he
17 was bound to tell us the truth?

18 A Well, unfortunately, up until fairly recently, I
19 had never met Mr. Slack. I knew nothing about Conam. So I
20 had no idea what was going through the subject's mind and
21 the RSO's mind. So I couldn't presume to guess that.

22 Q Okay. But also, in assuming the most likely and
23 taking what you said the first day, and I still am a
24 little, if you can help me with what Mr. Slack told you,
25 because what Mr. Slack has told us repeatedly is that what

1 Mr. Chastain told him was he stood at a point on the ladder
2 somehow between one and three feet and we know certainly at
3 the back limit of that, he can fly if he can do that. But
4 be that as it may, with his fanny pack closest point to the
5 exit port at all times, now if that's what he relayed to
6 you, I have a problem with why something other got more
7 than a 4.6.

8 A No. That's a fair question. Because we had the
9 NRC's data that showed that there were differences in
10 distance. And if I had made that assumption, frankly I
11 would have told Mr. Slack, well, why are you calling me?
12 You've got 4.6 REM on the badge. That's the dose of
13 record.

14 Q Then you didn't use what he said the first time?

15 A I used the collection information that he gave
16 me. He gave me also Mr. Chastain has a write-up here. I
17 used the NRC's information. I used all of the, you know, I
18 got a lot of stuff. And I created a scenario in my mind
19 and did a dose calculation based upon that.

20 Q And when you did that dose calculation for
21 Scenario A, you assumed a fixed point from source to thigh
22 and source to badge so that Mr. Chastain did not move at
23 all during the one to four minutes. And you plugged in
24 various distances and ultimately you just kept adjusting
25 the time until you got to one minute and it came out so the

1 film badge reading would be appropriate?

2 A Yes. That's in essence what I did. Is I created
3 a set of conditions so that the exposure rate at a given
4 point was exactly equivalent to what the film badge was.
5 And that set of conditions required that I either modify
6 time, distance or shielding and time is the logical, is the
7 easy one to modify. Like you said, if I did distance, he
8 might have been flying off the backs of the ladders.

9 Q Okay. And so in point of fact it was two
10 minutes, then even using your weighting factors, you'd be
11 pushed up close to the limit, the regulatory limit, and if
12 it was three minutes, you'd have been over the five REM
13 even with weighting factors, is that correct? The straight
14 linear progression? Because three minutes it would have
15 been three times as high a value as you calculated at one
16 minute?

17 A That's true. But the badge was at 4.6 REM. That
18 was limiting -- that put the upper limit on the time, was
19 the badge reading.

20 Q And I don't mean to oversimplify this, but what
21 you were doing out of the non-scientific basis in effect,
22 once you put in your shielding numbers and everything else,
23 the rest of it would be the equivalent to me sitting down
24 next April 15 with Turbo Tax and saying here's my W-2 and I
25 want to pay no taxes and I'm going to keep changing my

1 deductions until it comes out that way?

2 A No. Not quite. No. I did the exact same thing,
3 so to speak, that the staff did in their calculation. I
4 assumed a point source. I assumed a distance away from
5 that source. And then I did a calculation of what, it uses
6 the exact, probably, I don't want to attest to that. I'm
7 going to guess that the gamma constants in micro shield
8 would be very similar to the gamma constant that was used
9 by the staff. It worked the same way.

10 Q You only decided that all the variables. You
11 didn't decide you'd ever change the source strength, i.e.
12 the fact that he may have moved and depleted uranium may
13 have come into play, it may have twisted effect on your
14 Scenario 2. You assigned a gamma dose of 4.6 REM even
15 knowing that as the NRC calculation, for three-fourths of
16 the time that film badge had his body between him and the
17 film badge?

18 A That was a simplifying assumption because that
19 dosimeter was indeed being irradiated constantly for the
20 four minutes. But for three of that minutes it had however
21 many inches of tissue between it.

22 Q And so you thought a fair assumption is that
23 however thick Mr. Chastain was, there was no energy
24 absorbed that cut irradiation before it passed through the
25 body and deposited 4.6 on the badge?

1 A No, I didn't do that. I don't want to imply that
2 I did. That wasn't the reason for that. The reason why I
3 did that is I was indeed, and you've raised an interesting
4 technical point, and I'll give you that one.

5 Q I stumble on one every now and then.

6 A Yeah. Is I was indeed thinking on the ANSI
7 standard, which is there's a badge in the compartment. I'm
8 going to take the badge reading and press on.

9 JUDGE KELBER: Excuse me.

10 THE WITNESS: I could have calculated a dose to
11 the abdomen using micro shield. But I had to be careful
12 about that because I've got a film badge that's calibrated
13 a certain fashion. I can't talk to the way in which the
14 calibration was performed, but it's a direct beam radiation
15 to the front of the badge. It's being irradiated from the
16 back. I don't know that the film badge will respond the
17 same way.

18 And whether that film badge is going to give me
19 an equivalent response, I just chose to use the film badge
20 because there were too many other variables that would have
21 had to have gone into that assessment.

22 JUDGE KELBER: So you had more and better
23 calculation?

24 THE WITNESS: Pardon me?

25 JUDGE KELBER: You would have made more complete

1 calculations?

2 THE WITNESS: Pardon me?

3 JUDGE COLE: You would have made more complete
4 calculations?

5 THE WITNESS: I would have done more
6 calculations. I'm not sure I would have improved the
7 situation. If we make, we can do this here, we can make an
8 assumption that the film badge responds equally the same
9 whether it's irradiated from the front or irradiated from
10 the back. You know, and we can decipher what the increase
11 in the dose would have been to the abdomen compartment from
12 doing that.

13 BY MR. DAMBLY:

14 Q I'm just troubled by when first you made a
15 statement that you were just following the ANSI standard.
16 Is your testimony of the ANSI standard, if I have a film
17 badge on my back and I'm facing a highly collimated source
18 of radiation, then I'm supposed to say whatever gets all
19 the way through my body is the official dose?

20 THE WITNESS: No. That's not what the ANSI
21 standard says. The ANSI standard recommends that you put
22 the film badge at the location where you expect the
23 exposure to occur because you've preplanned the work.

24 BY MR. DAMBLY:

25 Q And in that point you weren't really on the ANSI

1 standard because one would only have a single dosimeter
2 start with them and two, it wasn't a place that would have
3 gotten the most radiation?

4 A That's correct. Taking the ANSI standard
5 literally, that would have been the case. But I have one
6 dosimeter in the compartment that gave me a reading, and I
7 would have been adding more assumptions if I tried to
8 incorporate the response of that dosimeter. I'm not really
9 sure that it would improve the quality of the dose
10 assessment. It would have been just more calculation.

11 Q Do you think 4.6 REM under your Scenario 2 with
12 three-quarters of the time with the body shielding the
13 badge, do you think that's accurate?

14 A No, I believe that's an underestimate.

15 JUDGE KELBER: Excuse me. May I ask a question?

16 MR. DAMBLY: Yes, sir.

17 JUDGE KELBER: Did in your calculation you take
18 account of the shielding afforded by the body?

19 THE WITNESS: When the dosimeter got turned
20 around?

21 JUDGE KELBER: Yeah.

22 THE WITNESS: Not for the abdomen compartment
23 result. I took the dosimeter result exactly as read.

24 BY MR. DAMBLY:

25 Q In point of fact what you basically did was

1 assume that he flipped his fanny back around backwards?

2 That would have given you the same reading?

3 A The assumption would have gotten you to the same
4 place. That's correct.

5 Q That would have been a more accurate assumption?

6 A Well, it would have matched that particular
7 exposure scenario, but again, I wasn't in a position to go
8 to the dosimeter processor. It would have made a more
9 complicated calculation and at that time I'm not that sure
10 it would have made a better calculation in light of the
11 other variables that are associated with it.

12 Q Are you aware of how much Iridium energy from
13 Iridium, whatever we're dealing with, is soaked up in body
14 tissue?

15 A Is soaked up?

16 Q Absorbed?

17 A I can look up a half value. I don't know off the
18 top of my head. I can look up a half value layer.

19 Q Do you think it's considerable or negligible? I
20 mean, you do this all the time? You should have
21 familiarity, I would think.

22 A Yeah. There is, 200 KEB gammas will be absorbed
23 in tissue. But 200 KEB gammas will pass through tissue as
24 well. I'd be guessing. I'd be speculating if I tried to
25 guess.

1 Q Are you familiar, let me just ask it, isn't it
2 true that 374 KEBs we're talking about?

3 A Is it 374? Well, then more of them will pass
4 through.

5 Q Let me ask you another question. Ultimately on
6 your Scenario A, which came out, which you said is what you
7 think is the most likely effective dose equivalent, you
8 ultimately came out with a one minute exposure time. You
9 went out and you did a recreation. And you had an
10 individual who hadn't been working for three hours who was
11 considerably taller than Mr. Chastain, longer arms, and who
12 wasn't actually doing radiography. So he didn't have to
13 make sure the camera was right, in the right position,
14 measure, whatever, and you couldn't come out with anything
15 less than a minute and a half.

16 MR. BROOKS: I'm going to object to the question.
17 Speaking of things not in evidence.

18 MR. DAMBLY: The video is in evidence.

19 MR. BROOKS: Right. For example, I think the
20 video shows Mr. Fay measuring. I'm not sure where the
21 assumption that Mr. Dambly made that there wasn't
22 measurements comes from.

23 BY MR. DAMBLY:

24 Q My assumption was very simple and I stated it
25 before. This was a mock-up, and I'm going to ask you to

1 assume that when somebody just does a mock-up, the care
2 with which one pays attention to this, because he wasn't
3 really taking a shot. If he screwed it up, it doesn't
4 really matter. But be that as it may, if you want to
5 assume he took full attention, that was a minute and a half
6 with a taller individual and whatever. You still think the
7 most likely scenario is that somebody actually performing
8 work and having been on the job three hours at that point
9 was, is that 50 percent faster than Mr. Fay when you did
10 the --

11 A I have no expertise in performing radiography.
12 The purpose for that dose reconstruction was to, from my
13 point of view, was to generally see how does a radiographer
14 perform this type of operation in that exact same
15 environment. Never once in my mind did I intend to use
16 what was going on with Mr. Fay as being exactly equivalent
17 to what would have been going on with Mr. Chastain. You're
18 right. They were not the same circumstances.

19 Q Let me find the right document. First of all,
20 before I even go to that, you said your purpose in
21 attending the reenactment was to see how radiographers
22 work. I mean, you had already done your report. You had
23 already issued it. You had two weeks before the hearing.
24 What is it that you thought you were going to learn at that
25 point?

1 A I was asked to attend the reenactment so that --
2 I had things in mind that I wanted to see when I was at the
3 reenactment. And that was the sole purpose for being
4 there. There were some things that I wanted to do at the
5 reenactment. And we just simply didn't have time. It took
6 almost, as I recall, almost three-quarters of the amount of
7 time we were there just trying to find the work location.
8 We didn't get to do what I had wanted to do.

9 Q Now, let me call your attention to what's
10 Exhibit 7. This is, if you look in, I'm sorry,
11 page, it's says one to five, forget page one, have you ever
12 seen page one?

13 A I've not seen this at all, no.

14 Q Okay. Now look into page two. Have you see page
15 two?

16 A I think so. I believe I have a copy of this
17 drawing, yes.

18 Q And page three and four are Mr. Chastain's write
19 up, the day after, in which you placed a high degree of
20 credibility, is that correct?

21 A No, I didn't place a high degree of credibility
22 on it. I just took his, his statement to Mr. Slack that he
23 was facing forward. I didn't judge that one way or the
24 other.

25 Q Did you read this document?

1 A Yes. And I read this document and he didn't
2 indicate in here that he turned around at all. So, it was
3 a reasonable next step.

4 Q All right. Let me --

5 MR. BROOKS: Your Honor, before Mr. Dambly asks
6 his next question, I'm wondering if as a general procedure,
7 Mr. Dambly would let the witness finish her answers before
8 we get the next question. We seem to, I know we got a lot
9 of good questions but they seem to keep jumping up on the
10 answer.

11 MR. DAMBLY: I'm sorry, if I'm cutting witness
12 off. It's not my intention. And I intend to, I'll be more
13 clear about it.

14 CHAIRMAN BECHHOEFER: We understand that. But
15 the advice is good anyway.

16 MR. DAMBLY: Thank you.

17 CHAIRMAN BECHHOEFER: Let her finish.

18 MR. DAMBLY: And I'm sorry if I'm cutting you
19 off.

20 BY MR. DAMBLY:

21 Q Now, on what's listed as page three of five, on
22 Exhibit 7, this is the document you received from
23 Mr. Slack, it's noted in your report.

24 A Yes. This I believe is a copy of the document
25 that I have.

1 Q And you read that document.

2 A Yes, I did.

3 Q And if I could call your attention to, let's see,
4 one, two, three, four, five, six, seven lines up from the
5 bottom, you see by the middle, it says, I began doing my
6 survey of the camera, note camera was about a 60 degree
7 angle to me with the open end pointing away from me. Did
8 you take that at all it wasn't a perpendicular on the
9 ladder?

10 A I assumed he did a survey before he got on the
11 ladder. That's what I would have done.

12 Q I see. With respect to time, it says here, he
13 began shooting at 3:30 p.m., it's like eight or ten lines
14 down. And it says, at 6:30 p.m., he went in and this event
15 started. And the line in front of that says, I had made 15
16 exposures with no apparent promptness.

17 Now from 3:30 to 6:30 is three hours, is that
18 correct?

19 A Yes, that's correct.

20 Q And I'm sure you don't need a calculator to know
21 that would be five exposures per hour, is that correct?

22 A If I assume that's all he was doing was those 15
23 or what is it, yeah, 15 exposures.

24 Q And that would be 12 minutes per exposure.

25 A Yeah, if that's all he was doing.

1 Q And if I was to tell you that Mr. Chastain
2 testified that it was one minute per exposure when he was
3 actually using the source that they gave X-ray, that leaves
4 11 minutes per exposure. Did you stop and ask him, well,
5 what was going on those nine minutes, was one minute a
6 reasonable time and did he spend cigarette break in between
7 each one?

8 A Well, to be real honest, I wasn't paying any
9 attention at all to what he did before this exposure. I
10 was only interested in orientations and thicknesses and
11 time durations of this exposure.

12 Q Well, what did you do to assure yourself that
13 when you came out with what was your most reasonable, most
14 reasoned scenario that it had any basis in fact.

15 A I don't want to be misleading on that. One, I
16 felt that scenario was the most likely is simply because
17 his description of the way he was facing the device was
18 given closer to the point in time when it occurred. I was
19 thinking memory as being the one that would be most likely
20 to perturb that but the fact of the matter is that I have,
21 I can't place a greater degree of confidence frankly on any
22 of these now as time has gone on and we have learned more
23 and more things.

24 Q But even taking the most, what you're calling the
25 most likely, assumed he told you was between one and four

1 minutes and ultimately you came down with the least
2 conservative estimate, one minute --

3 A No --

4 Q -- what's the most likely.

5 A -- no, that's not true. I came up with an
6 estimate that preserved the relationship with the
7 dosimeter. We had to do that. We had to make an
8 assumption much like the staff had to that the dosimeter
9 reading was correct.

10 Q So ultimately you just worked out whatever
11 numbers happened to agree with the film badge and what you
12 calculated as the source?

13 A There's no other way to perform this dose
14 assessment.

15 Q If you'd come out 30 seconds, would that have
16 been appropriate?

17 A That's correct. There was no other way to
18 perform this dose assessment. Wait a minute, I lied or not
19 lied, I misspoke. I could have adjusted time or I could
20 have made an adjustment of distance or I could have made an
21 adjustment of source strength those are, they accomplish
22 the same thing.

23 Q Did you take, did you make any measures, did you
24 get a ladder and stand on it and try and get any feel of
25 how close or how far one could be and what the likely

1 ranges really were?

2 A Did I personally do that --

3 Q Sure.

4 A -- as a result of this incident, no, I did not.

5 Q Did you have anybody else do it?

6 A Pardon me?

7 Q Did you or anybody else do it?

8 A Yes, the NRC did that in their -- well, that's
9 the date -- I'm sorry, I don't mean to be short.

10 Q No, that's okay. Did you do any any regression
11 analysis for the CI sensitive, various things in your
12 calculations?

13 A No.

14 Q Did you have any statistical confidence in your
15 numbers?

16 A Without knowing the range of error associated
17 with every aspect and every assumption that went into this
18 it would be impossible to propagate the error.

19 Q And now based on the recreation that you there
20 present at none of those scenarios that you saw Mr. Fay re-
21 enact correspond with any of your scenarios is that right,
22 either one of the two that you presented in here?

23 A Identically, no, absolute, no, absolutely not.

24 Q I think in the first two that were pointed out
25 yesterday that whatever Mr. Chastain may have testified to

1 is probably different. But Mr. Fay had his gonads between
2 his film badge at all times on the first two?

3 A Yes, I believe that he was told to push his film
4 badge behind, that's correct, yes.

5 Q And from your experience that wouldn't be a
6 normal practice I would assume for a radiographer?

7 A I don't have any radiography experience but I do
8 have experience wearing dosimeters both at waist height and
9 chest height and you tend to forget they're there unless
10 you they get in the way. And so the only reason I can
11 think of why he would twist it around if it was physically
12 getting in his way.

13 Q Well, from your experience, normally you would
14 wear your film badge on the part of your body which you
15 assume is going to be closer to the source. You wouldn't
16 use your body as a shield for your film badge would you?

17 A When one is using a single dosimeter for routine
18 personnel dosimeter you want to typically mount that
19 somewhere on the trunk of the body. If there's a reason to
20 think that the exposure is going to be higher in another
21 location just from a general, general health practice and
22 you're interested in knowing what that other location is
23 than you're going to put more dosimeters on someone.

24 MR. BROOKS: Okay, just a moment, maybe we're
25 close to dinner. I guess, I just have one last question.

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REDIRECT EXAMINATION

BY MR. BROOKS:

Q Did you at any time consider using any other calculation or methods in preparing this assessment, for example, an adjoining calculation using transport theory or Monte Carlo calculations?

A Did I consider doing that?

A No, I, I was only contracted to provide this dose assessment, everything else, no--

Q All right, thank you.

A -- there was no need to continue on.

MR. BROOKS: No further questions at this time.

CHAIRMAN BECHHOEFER: Yeah, at this stage, let's take a five minute break.

(Short recess taken.)

CHAIRMAN BECHHOEFER: Back on the record.

JUDGE KELBER: Before you begin your redirect, Ms. Berger, in that now famous Footnote 23, you indicated that a slight change in the source position in the shields within the labyrinth S-curve would make a dramatic change in the dose at the, at the supposed film badge location.

MS. BERGER: Yes, that's the, if the slight change brought it past high Z material.

1 JUDGE KELBER: Now, did it, did you suggest as a
2 professional, as an expert, consultant in this field, to
3 Conam that you explore these, such intermediate positions
4 to get a more accurate representation.

5 MS. BERGER: No, I did not.

6 JUDGE KELBER: I see. Do you consider that a
7 responsible action as a consultant in a case like this?

8 MS. BERGER: To be honest I didn't, I wasn't sure
9 that would have improved the position very much. In order,
10 if I would have brought the source back farther -- I'm not,
11 I picked a set of assumptions that I thought were
12 reasonable. I really honestly felt from day one that I was
13 accurately depicting what happened to Mr. Chastain. And
14 where the source and where the device was and I stopped
15 there. I wasn't really sure that by continuing to fine
16 tune it that I would improve upon the quality of the
17 result.

18 JUDGE KELBER: So, in fact you really have very
19 little confidence that you're, that we can use your
20 calculations to get a good estimate of what actually was,
21 what dose he absorbed.

22 MS. BERGER: I think there are pros and cons to
23 the calculation that I did. There are pros and cons to the
24 calculations that the Staff did. We can make similar
25 assessments on just sheer exposure rights that that

1 Mr. Slack used. There's pros and cons to that. I think
2 that that we can probably calculate the dose ten or 15
3 times' and end up with numbers that are probably in the same
4 ballpark.

5 JUDGE KELBER: I don't understand that remark
6 because you did a calculation where you withdrew the source
7 into the shield. And the --

8 MS. BERGER: Oh, I see what you're saying.

9 JUDGE KELBER: -- yes --

10 MS. BERGER: That's correct, yes.

11 JUDGE KELBER: -- So I don't understand the
12 origin of that remark.

13 MS. BERGER: I probably misspoke, you're correct.

14 JUDGE KELBER: Now I know what basis, I have a
15 suspicion that I know what basis the Staff would suggest we
16 use for deciding the issue of whether that there was a
17 violation of the regulatory vivid zone, absorb dose. Can
18 you suggest what basis we should use to make such an
19 assessment?

20 MS. BERGER: Clearly one of two things happened
21 here, either Mr. Chastain was exposed to a relatively
22 uniform, relatively homogenous source of radiation in close
23 proximity or he was exposed to something that was radiating
24 just a portion of the body at a higher dose than the rest
25 of the body.

1 If he was exposed to something that was sort of
2 an ambient field while he was standing down at the bottom
3 of the ladder, he was at the side of the device and his
4 head was being exposed and then he stood up and granted he
5 had more time by his thigh that he in no way, shape or form
6 spent the entire time by his thigh.

7 In that case, we thought circumstances that are
8 very similar to probably the type of work Mr. Chastain does
9 all the time, so the badge should be taken then in that
10 case as the recommended dose.

11 But if the beam was calumniated an attempt has to
12 be made to calculate the dose to the, to the area that
13 could have received the highest possible exposure and then
14 the other areas as well. I felt like the approach that I
15 presented was a reasonable approach. There were
16 assumptions that as the scenarios changed the picture is
17 not quite correct. I don't know that that beam of
18 radiation was heading directly to his thigh or at an angle
19 at his thigh, it just seemed like a reasonable assumption
20 to make at the time. I don't have any problem with
21 Mr. Chastain submitting our dose assessment as the support
22 of the dose of record. I don't think --

23 JUDGE KELBER: You mean --

24 MS. BERGER: -- I'm sorry, Mr. Slack.

25 JUDGE COLE: You mean the film badge as the dose

1 of record.

2 MS. BERGER: Submitting our dose assessment if
3 it's a non-uniform exposure.

4 JUDGE COLE: That's a non-uniform exposure.

5 MS. BERGER: That's correct.

6 JUDGE COLE: You leave us in a very unenviable
7 position. We have to, we're in the position of calling
8 balls and strikes and we're in a situation where the
9 pitcher is throwing to first base, so we don't know where
10 home plate is. Somebody has to help us determine where
11 home plate is and I don't think anybody's willing to do
12 that or able to do it.

13 JUDGE COLE: Ms. Berger, just really one
14 question. You apparently have a great deal of experience
15 in dose assessment. And if you were faced with a
16 situation, let me start again. You're familiar with the
17 information that was available to Mr. Slack on the 28th or
18 29th of February 1996, are you?

19 MS. BERGER: Yes, the information he relayed to
20 me, that's correct.

21 JUDGE COLE: And are you familiar with his
22 viewpoint of that overall situation back then with respect
23 to what was truth with respect to dose in his mind?

24 MS. BERGER: Yes, I believe that Mr. Slack felt
25 that the general radiation field where Mr. Chastain was was

1 relatively uniform except that his dosimeter was probably
2 closer to the source than the rest of the body and
3 therefore, he felt that the badge result -- it's my
4 impression. I hope I'm not putting words in your mouth,
5 that the badge result was the closest approximation.

6 JUDGE COLE: Now with respect to the attitude of
7 the people that evaluate doses use all sorts of film badges
8 and instrumentations to measure those doses, I get a sense
9 that there's a feeling among those people that the most
10 valuable piece of information that they have in most
11 instances is the film badge dose, is that correct?

12 MS. BERGER: Yes, it is.

13 JUDGE COLE: And what instances would the film
14 badge not be the best indicator?

15 MS. BERGER: Well, there's a lot of
16 circumstances. But it depends upon what you're inpoint is.
17 If you're inpoint is calculating effective dose equivalent,
18 again, a non-uniform exposure would render the film badge
19 dose not the best indicator of the effective dose
20 equivalent.

21 JUDGE COLE: Did Mr. Slack have any indication of
22 that situation on the 28th or the 29th?

23 MS. BERGER: He never relayed that to me.

24 JUDGE COLE: Okay, thank you.

25 CHAIRMAN BECHHOEFER: That's all the questions we

1 have at the moment.

2 MR. BROOKS: If the Panel would permit it, I
3 think I have no further questions for the witness. Thanks
4 very much for your time, Ms. Berger. I really appreciate
5 it.

6 JUDGE COLE: Thank you.

7 JUDGE KELBER: Thank you.

8 MR. DAMBLY: I have nothing further.

9 CHAIRMAN BECHHOEFER: You get the follow up.

10 MR. DAMBLY: I know but thank you for the
11 opportunity. Thank you, I'm done.

12 CHAIRMAN BECHHOEFER: Ms. Berger, thank you very
13 much.

14 Now, I inquire whether the Staff wishes to
15 present some rebuttal.

16 MR. DAMBLY: Could we just have --

17 CHAIRMAN BECHHOEFER: It's your opportunity to do
18 so.

19 MR. DAMBLY: -- could we just have two minutes.
20 I think our answer is no, but let me have two minutes. And
21 if it's allowed, we'll get you out early --

22 CHAIRMAN BECHHOEFER: Well, no, you have a right
23 to present rebuttal.

24 MR. DAMBLY: I know -- it is with much delight
25 that I say, we are through.

1 CHAIRMAN BECHHOEFER: Okay. Before we adjourn or
2 close the record completely, we ought to discuss the
3 submission of findings. And the submission of the total
4 findings of fact includes -- law and that type of thing.
5 All parties have the right to present those findings.

6 There are a couple of ways this could be done.
7 The rules themselves as they are now written have the
8 parties submit consecutively the Staff will go first,
9 the Respondent continue respond and the Staff would have
10 some chance for reply.

11 Alternatively, we could have simultaneous
12 filings, findings. And the Commission is and the policy
13 states that, seemed to sanction that where it's
14 appropriate. At least they allow some discretion whether
15 we do it that way, I believe that if we did it that way, we
16 would also want to permit each party to respond to the
17 other, just to be fair.

18 But I'll, we'll leave it to you because, what you
19 would prefer doing. If the Staff would, if we do
20 consecutive finding, normally the Staff would have to set
21 out what it is what we should have in our entire decision
22 and that might be many paragraphs of that -- I have no
23 objection. The fact of the matter is hearing some X
24 date -- et cetera. But as long as we know the Staff will
25 put that type of finding in any event, I guess, you're

1 going to elect whether or not, if we did simultaneous
2 filing. You either select whether wish to to file those
3 than in terms of allowing a reply, Respondent to reply, you
4 could correct anything that wasn't apparent from the start.

5 So, I give you your choice, do you have any
6 particular choice?

7 MR. BROOKS: I think for Conam we have a small
8 preference for consecutive filings only because it means
9 that we'll prepare one document instead of two, which we
10 would file if they were simultaneous filings and then
11 everybody made a response. The only advantage to the Board
12 is consecutive filings, the Board ends up with three
13 documents instead of four. But other than that, I don't
14 see --

15 CHAIRMAN BECHHOEFER: So you would prefer the
16 simultaneous --

17 MR. BROOKS: No, I prefer the consecutive.

18 CHAIRMAN BECHHOEFER: Oh, consecutive.

19 MR. BROOKS: Consecutive, that way, we only write
20 one document and you only get three instead of four.

21 CHAIRMAN BECHHOEFER: Right. I would --

22 MR. DAMBLY: I don't think anybody's going to
23 complain about the time frame.

24 CHAIRMAN BECHHOEFER: Okay, well, I think the
25 Board will approve the consecutive findings as they are

1 written in the rules now.

2 Now as for timing, I believe the Staff would have
3 30 days from the close of the record without looking it up
4 specifically that's my recollection. Is that time
5 satisfactory or do you think more time might well be
6 needed, particularly we could regard, at least, the close
7 of the record should not, that date should not be until
8 people have received their transcript for today. Because I
9 think it unfair to --

10 MR. DAMBLY: We would ask for 45 days.

11 CHAIRMAN BECHHOEFER: -- From today which is --

12 MR. DAMBLY: Today which is the 18th. If you're
13 not going to start writing today, how about Monday.

14 CHAIRMAN BECHHOEFER: No, you're not going to get
15 the final print --

16 MR. DAMBLY: Okay, if Monday is the 21st, 30 days
17 should be October 21st, somewhere, I don't know what's the
18 first Friday in October?

19 CHAIRMAN BECHHOEFER: I'll tell you in a minute.

20 MR. DAMBLY: In November, I'm sorry.

21 MR. BROOKS: The 6th, November 6th.

22 MR. DAMBLY: Is that 45, pretty close.

23 CHAIRMAN BECHHOEFER: Would November 6th be a
24 satisfactory date.

25 MR. DAMBLY: November 6th is a satisfactory date.

1 CHAIRMAN BECHHOEFER: Okay. How much further
2 time, if we take away the rules technically, we've been
3 going about ten days, I don't think --

4 MR. BROOKS: I guess I would like 30 days, if we
5 could have it to perhaps to December 7th.

6 JUDGE COLE: Pearl Harbor Day?

7 MR. BROOKS: You guys are clever.

8 CHAIRMAN BECHHOEFER: Okay, December 7th for the
9 licensee. How much more time would the Staff need?

10 MR. DAMBLY: How about Friday, a week after the
11 7th, what would that be?

12 MR. BROOKS: That would be December 18th.

13 MR. DAMBLY: December 18th, if we're not done
14 before then -- between the 18th -- after the first --

15 MR. BARTH: Your Honor, Mr. Brooks hasn't -- our
16 agency before in the beginnings of these is a whole big
17 background section, I will engage the right of background
18 section so you don't have to redo it, all you got to do is
19 have Conam to find errors in it. So you could say you
20 adopted some, follow and correct it.

21 MR. BROOKS: Yeah, we appreciate that.

22 CHAIRMAN BECHHOEFER: Yeah, we're all going to
23 put the background and opinion --

24 MR. DAMBLY: You are, I'm trying what we will be
25 not what you --

1 JUDGE KELBER: In other words the two parties
2 will collaborate on --

3 MR. BARTH: No, we will not -- background section
4 adopt such changes he feels --

5 JUDGE COLE: You might want to consider sending
6 him his own disk also --

7 MR. BARTH: Oh, we'll send the disk back and
8 forth.

9 JUDGE COLE: In other words, you'll give the
10 licensee an attach to, enter corrections into the
11 background record, is that what you said?

12 MR. BARTH: How can I say this more clearly, we
13 will file a docket, we'll have a background.

14 JUDGE COLE: Okay.

15 MR. BARTH: Thirty days later, he will file
16 docket, attached background --

17 JUDGE COLE: Yeah, you said it clearly and thank
18 you.

19 MR. BARTH: Thank you. Okay.

20 CHAIRMAN BECHHOEFER: December 18th, that's the
21 Staff's final -- I might say if worse comes to worse, we
22 have a party to extend those times. You just have to ask
23 and let us know before the date runs out, if you need more
24 time.

25 JUDGE KELBER: While we can't dictate anything

1 that you put into your findings, it would be a great help to
2 us, if you would in your findings depose, as well as you
3 can, how we can resolve this difficult question of what, in
4 fact, is the most likely value of the absorbed dose that
5 Mr. Chastain received.

6 MR. BROOKS: Seems like a pertinent question.

7 CHAIRMAN BECHHOEFER: Is there anything further
8 before we adjourn that you wish us to take up?

9 MR. BROOKS: For Conam and I'm sure for the Staff
10 have been, enjoyed the proceeding and really have been
11 impressed with the Board's attentiveness and a little
12 humbled by the frequency with which the Board's questioning
13 was far more incisive than ours. But we really appreciate
14 your time and attention to this.

15 MR. DAMBLY: We will second that.

16 CHAIRMAN BECHHOEFER: We appreciate the efforts
17 of all the parties, both parties and appreciate your
18 devoting effort that you have prepared base material.

19 And with that, the hearing is adjourned.

20 MR. DAMBLY: Thank you.

21 MR. BROOKS: Thank you.

22 (Whereupon, at 2:42 p.m., the hearing was
23 concluded.)

24

REPORTER'S CERTIFICATE

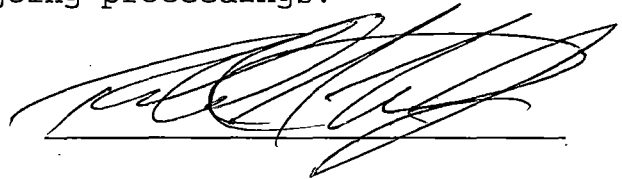
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