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UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

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ADVISORY COMMITTEE ON NUCLEAR WASTE (ACNW)

173rd MEETING

+ + + + +

THURSDAY,

SEPTEMBER 21, 2006

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VOLUME IV

+ + + + +

The Advisory Committee met at 8:30 a.m. in Room T-2B3 of the U.S. Nuclear Regulatory Commission, One White Flint North, 11555 Rockville Pike, Rockville, Maryland, DR. MICHAEL T. RYAN, Chairman, presiding.

MEMBERS PRESENT:

MICHAEL T. RYAN, Chairman

ALLEN G. CROFF, Vice Chairman

JAMES H. CLARKE, Member

WILLIAM J. HINZE, Member

RUTH F. WEINER, Member

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NRC STAFF PRESENT:

CHRIS BAJWA

EARL EASTON

JOHN T. LARKINS, Executive Director, ACRS/ACNW

MIKE LEE

DEREK WIDMAYER

ALSO PRESENT:

HAROLD ADKINS, Pacific Northwest National
Laboratory

I-N-D-E-X

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

(8:35 a.m.)

28) OPENING REMARKS BY THE ACNW CHAIRMAN

CHAIRMAN RYAN: We will come to order.

This is the fourth day of the 173rd meeting of the Advisory Committee on Nuclear Waste. During today's meeting, the Committee will consider the following: disposition of public comments on spent nuclear fuel transportation package responses to tunnel fire scenarios, NUREG CR-6886 for the Baltimore tunnel fire and NUREG CR-6894 for the Caldecott fire.

We completed our discussions of letters on Monday. So we will not have any detailed discussions other than those appropriate to the creation of letters from the two-day working group that we had on modeling and monitoring.

The meeting is being conducted in accordance with the provisions of the Federal Advisory Committee Act. Mike Lee is the designated federal official for today's initial session.

We have received no written comments or requests for time to make oral statements from members of the public regarding today's sessions. Should anyone wish to address the Committee, please make your wishes known to one of the Committee staff.

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1 It is requested that speakers use one of
2 the microphones. In a small room, that might not be
3 too hard to do. And speak with sufficient clarity and
4 volume so they can be readily heard. It is also
5 requested that if you have cell phones, you kindly
6 turn them off. Thank you very much.

7 Without further ado, I'll turn the session
8 over to our progressive member, Ruth Weiner. Ruth?

9 MEMBER WEINER: I can borrow an agenda?

10 CHAIRMAN RYAN: Please.

11 MEMBER WEINER: Our speakers today are
12 going to be Earl Easton and Chris Bajwa, who will
13 discuss the Baltimore and Caldecott tunnel fire
14 studies. I understand the draft document was issued.
15 There were comments on the draft document. And one of
16 the points of the discussion will be the resolution of
17 those comments.

18 29) DISPOSITION OF PUBLIC COMMENTS ON
19 SPENT NUCLEAR FUEL TRANSPORTATION PACKAGE
20 RESPONSES TO TUNNEL FIRE SCENARIOS

21 MR. EASTON: Good morning. Thank you, Dr.
22 Weiner.

23 Today myself, Earl Easton with the Spent
24 Fuel Project Office; Chris Bajwa; and Harold Adkins
25 will be going over the responses to the two studies we

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1 did: one on the Baltimore tunnel fire, which was a
2 rail tunnel fire; and the Caldecott tunnel fire.

3 These were published last fall. They were
4 put out for publish. These were published in draft.
5 They were put out for public comment. We did receive
6 a number of comments, both from the public, from the
7 ACNW, when we initially briefed you on the Baltimore
8 tunnel fire. We had a number of internal staff
9 comments. And, of course, the last thing we would
10 like to focus on is your questions because they have
11 always been helpful in guiding us.

12 To start with, we got comments from four
13 sources from the public request. And they were from
14 the Northeast High-level Radioactive Waste
15 Transportation Project; the Brotherhood of Locomotive
16 Engineers and Trainmen; the State of Nevada, their
17 agency for nuclear projects; and one from a private
18 individual.

19 I think we circulated these last night to
20 the Committee electronically. And what I'm referring
21 to is an appendix which will be in the back of the
22 study, which is a more detailed discussion of how we
23 addressed each specific comment with more detail than
24 the ones that we're going to discuss today.

25 Today's approach is basically we sorted

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1 the comments and sort of picked out what we thought
2 were the major areas of focus. And those are the
3 comments we got on the location, severity, and
4 duration of the fire; the fact that the initial study
5 did not consider lead melt for the NAC-LWT TCAST; the
6 composition that we assumed for CRUD. We assumed it
7 was all cobalt-60 for simplicity.

8 We had a comment on the potential loss of
9 lead shielding. We had comments on how do you
10 consider fuel that might be damaged or high burn-up,
11 brittle at being shipped. We had some comments on the
12 performance of cask seals.

13 And we also had some comments, "Well, this
14 is just really basically looking at the consequences.
15 Can you put it in some sort of risk perspective?"
16 And, again, there were some individual comments in
17 appendix G that are more specific topics that we won't
18 really discuss unless a question comes up that you
19 might have.

20 Again, just to set the stage, this is our
21 basic model that we used. There was no spent fuel
22 cask in either one of these accidents. So we're
23 playing a "What if?" game. The model assumed a tank
24 car, a buffer car, and as spent fuel car. And, of
25 course, they're separated by about 20 meters in the

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1 model.

2 The fire started in a leak in the tank car
3 and then engulfed the whole tunnel. Basically it
4 burned in a pool area. And that fire heated the
5 tunnel, which then re-radiated heat into the cask.
6 And that's basically the model.

7 We use a duration of 7 hours followed by
8 23-hour cool-down. During that cool-down, of course,
9 the tunnel is continuing to radiate heat. And we got
10 the temperature profiles primarily from work done by
11 the National Institute of Standards and Technology,
12 NIST.

13 The first area that I am going to address
14 is the location, intensity, and duration of fire.
15 Comments basically were, did you put the cask close
16 enough to the fire? Would it have been worse had you
17 have placed the cask closer to the tank car?

18 The duration of the fire, couldn't it have
19 been more than seven hours? Is that the appropriate
20 length of time? And couldn't the fire have burned
21 hotter?

22 First, addressing the location of spent
23 fuel cask, we would call the attention of the
24 Committee to requirements that DOT has on the
25 placement of spent fuel and high-level waste in

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1 trains. They have a regulation -- it's 49 CFR 174.85
2 -- that requires a non-placarded, nonhazardous car to
3 intervene between spent fuel casks and any other class
4 of hazard, such as flammable liquid.

5 This is a depiction of an actual shipment,
6 spent fuel cask in the middle. You see the two buffer
7 cars. The tank car if it had been present in this
8 shipment would have been on either side of those two
9 box cars, but that's to give you an indication of the
10 spacing.

11 When you apply that, when you look at what
12 really happened at the tunnel -- and this diagram in
13 the upper left-hand corner is modified from the
14 National Transportation Safety Board report, but this
15 is a sketch -- cars 47 through 55 derailed. Car 52
16 was the tripropylene tank car.

17 So had theoretically a spent fuel cask
18 been in that manifest for that train, it would have
19 been perhaps in site 54 or site 50 with 51 and 53
20 being the buffer cars. Okay?

21 Could you have gotten the tank car closer?
22 Well, if you look at a schematic of the tunnel looking
23 end on, you see that there is not really much room to
24 go around a tank car. And there's not really much
25 room, really, to go override a tank car for the --

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1 should I say the buffer car.

2 If you look top view, we have 3 rail cars
3 basically 60 feet -- dueling lasers here. We have 3
4 rail cars roughly 60 feet in length. The tunnel is
5 about 15 feet. And even if you try to squeeze them
6 together, you don't really get much closer. So we
7 think, really, what this indicates is the
8 effectiveness of the DOT rule. This is, indeed, why
9 the rule was implemented.

10 The fire intensity. Let me just go over
11 how we derived the intensity that was used in the
12 study. When we had NIST actually go and analyze the
13 fire, they calculated based on their models -- and,
14 again, their models are benchmarked in actual tunnel
15 fire experiments -- that the amount of heat input
16 would have been around 1.7 times 10^8 Btu, or
17 50-megawatt, fire.

18 They predicted in the first half-hour to
19 an hour that the fire would become oxygen-starved.
20 And this is a picture from their report that they used
21 to explain that. Fresh air is trying to come here,
22 and it gets entrained here. And it's being forced
23 back out on the sides. And it's being used, oxygen is
24 being used, at a much faster rate than it can enter
25 into the tunnel.

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1 Again, this is in an unventilated tunnel.
2 Some tunnels are ventilated. They predicted a peak
3 temperature in the range of 1,800 to 2,000 degrees
4 roughly. And the hottest temperature that their model
5 predicted were really within the first half-hour but
6 within the first hours, to be certain, was about 1,472
7 degrees Fahrenheit at the ceiling above the source of
8 the leak. And the peak ceiling temperature at the
9 cask surface, which is, again, some 60 feet down, only
10 rose to 752.

11 This is their actual prediction modeling
12 of the fire as it occurred. Okay. What did we use?
13 We assumed an intensity ten times this high. We
14 assumed a 500-megawatt fire, 1.7 times 10^9 Btu per
15 hour. And how did we get that fire? Well, in the
16 model we actually had to physically punch holes in the
17 tunnel to get in enough oxygen. You know, this is
18 stoichiometric for the chemical engineers in the
19 audience.

20 We actually burned all the fuel. We know
21 in the real accident that some of the fuel didn't
22 burn. I know my colleague Chris has found news
23 articles that a day or so later some sewer lids had
24 popped because some of the propylene had migrated and
25 had pockets. But NIST told us a lot of this probably

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1 just vaporized or soaked into the ground and really
2 didn't participate in the initial fire.

3 We assumed that it was all burned and none
4 lost to vaporization or seepage. That led to a peak
5 temperature of 2,084 in the flame region, which is a
6 little higher. And the temperature at the cask, where
7 you have the ceiling, the brick ceiling, above the
8 spent fuel cask, where it would have been placed,
9 about 1,830-some degrees Fahrenheit. And that lasted
10 for over three hours in their seven-hour model,
11 seven-hour fire.

12 So we believe that we appropriately
13 modeled an intensity that is realistic. The duration,
14 the Baltimore tunnel fire lasted --

15 CHAIRMAN RYAN: Let me ask you a question.
16 How is it realistic if it's ten times more the
17 realistic envisions? It's a bounding case.

18 MR. EASTON: Right.

19 CHAIRMAN RYAN: A couple of things strike
20 me. One is -- and, you know, I understand what you
21 did, but you got very significant digits on
22 temperatures, like three.

23 MR. EASTON: Right, right.

24 CHAIRMAN RYAN: And, yet, you assumed ten
25 times higher. So some of the specificity that you

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1 have in your slides and then just jacking up by a
2 factor of ten notes you will be exactly consistent.

3 MR. EASTON: Okay. Good question. When
4 I say realistic, this tunnel was not ventilated. In
5 real life, sometimes you have tunnels that are
6 ventilated. You could get oxygen flow.

7 So what we did is we said if you got to
8 all the oxygen flow that you needed to support the
9 fire, how big would it be? And this is where we came
10 up with a factor. It could be a factor of ten times
11 higher. So it is more realistic if you have a
12 ventilated tunnel.

13 Does that answer?

14 CHAIRMAN RYAN: It does. Does the
15 document explain the basis for the factor of ten?

16 MR. ADKINS: Yes. It's in the NIST
17 document, the document --

18 CHAIRMAN RYAN: It's in a different
19 document. That's not as high-focused in your
20 document. And you explain the basis.

21 MR. ADKINS: Actually, we have added
22 verbiage over that. Harold Adkins from PNNL.

23 We have gone ahead and added verbiage to
24 the document that explains the fact that it could have
25 been a tunnel that involves ventilation, like current

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1 tunnels, because this tunnel is fairly old and then
2 also the potential for the fuel not to seep or
3 anything else like that into the ground or not
4 participate in the combustion process.

5 CHAIRMAN RYAN: So the factor of ten is
6 probably a realistic scenario --

7 MR. ADKINS: Yes.

8 CHAIRMAN RYAN: -- based on your other
9 assumptions?

10 MR. ADKINS: Yes.

11 CHAIRMAN RYAN: Okay.

12 MR. ADKINS: If the fuel is not to seep or
13 go below into the water drainage system or what have
14 you and then there is enough oxygen to participate in
15 the combustion process, those are the numbers that you
16 would come up with.

17 CHAIRMAN RYAN: Okay. I think that's a
18 very important distinction because when you say, "We
19 assume ten times more," that sort of gives the
20 impression that you're --

21 MR. ADKINS: Yes.

22 CHAIRMAN RYAN: -- in a world that's way
23 above reality, but what I'm hearing now is we're
24 probably on the center line of reality.

25 MR. ADKINS: Right. And we wanted to make

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1 sure of the potential, you know, if there was another
2 tunnel or scenario that --

3 CHAIRMAN RYAN: Yes. If it was as clearly
4 laid out in the document, I think that's helpful. But
5 if it just looks like you assumed a factor of ten
6 higher for no apparent reason, that's not good.

7 MR. ADKINS: Understandable.

8 CHAIRMAN RYAN: Okay. Great.

9 MR. EASTON: And I should mention that all
10 of the comment areas that were gone over, substantial
11 revisions were made to the document.

12 CHAIRMAN RYAN: Fair enough.

13 MR. EASTON: Okay. And then we tried to
14 link it back to the original document, too.

15 The NIST analysis used pool size, a
16 reasonable pool size, because that determines how fast
17 the fuel was consumed. So it basically is roughly a
18 25-foot by 25-foot or the footprint of a tank car, a
19 rail car as the pool size. And if you supply it with
20 all the oxygen it needs, it would consume that in
21 about 6.7 hours. We think that to be a reasonable
22 proximation.

23 Just to give you a little linkage to some
24 of the other studies that we have done, 6672 was a
25 major examination of spent fuel shipment risk.

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1 They have a table in that document that
2 says 99 percent of large train fires last less than 7
3 hours. And they also have in there experimental data
4 which say that a fully engulfing fire would under a
5 rail cask last approximately 7 hours, too.

6 CHAIRMAN RYAN: What about those one
7 percent?

8 MR. EASTON: What about the?

9 CHAIRMAN RYAN: The one percent? Are they
10 three days or a week?

11 MR. EASTON: No. And, again, this in 6672
12 was an interpretation of FRA data. We have gone back
13 and looked at FRA data.

14 CHAIRMAN RYAN: I lived in Augusta,
15 Georgia, near Augusta, Georgia. And there was a train
16 that burned for four days there. So, I mean, is it a
17 big difference?

18 MR. EASTON: No.

19 CHAIRMAN RYAN: How do we know that?

20 MR. EASTON: Well, when you say that the
21 fire lasted for four days, I think you've got to be
22 very careful.

23 CHAIRMAN RYAN: Why not?

24 MR. EASTON: For example, the train --

25 CHAIRMAN RYAN: The train was engulfed,

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1 all the cars, for four days.

2 MR. EASTON: Yes.

3 CHAIRMAN RYAN: It burned like crazy.
4 Towns were evacuated.

5 MR. EASTON: Right. But that's not
6 unusual because if you have, like, for example, a
7 propane tanker on fire, it will get a hole and it will
8 leak some out. And it will catch fire. And then the
9 standard practice is not to put that fire out unless
10 you can plug the leak. And sometimes these things
11 take 15 days to burn out.

12 They look like they're fully engulfing.
13 Firemen are cooling the other end to keep it cool so
14 it doesn't levee. That's why you have people
15 evacuated for the time length.

16 CHAIRMAN RYAN: Again, what I'm reaching
17 for is all that rich detail which helps you understand
18 that 99 percent of large train fire last 7 hours or
19 less.

20 MR. EASTON: Right. We're going to get --

21 CHAIRMAN RYAN: I need to know about the
22 other one percent to know I'm comfortable with that.

23 MR. EASTON: Okay. We're going to get to
24 that a little later on.

25 CHAIRMAN RYAN: Fair enough.

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1 MR. EASTON: We're going to get to that a
2 little later on when we put it into risk perspective.

3 CHAIRMAN RYAN: Ah. Now we're talking.

4 MR. EASTON: Okay?

5 CHAIRMAN RYAN: I'll wait.

6 MR. EASTON: Okay.

7 CHAIRMAN RYAN: Now you know where I'm
8 going.

9 MR. EASTON: Yes, yes. And that's where
10 we were headed, too, I think.

11 CHAIRMAN RYAN: Great.

12 MR. EASTON: So, in conclusion, on these
13 comments, we think that the location selected based on
14 the regulatory requirements for shipments was
15 realistic. We think the intensity and duration
16 modeled exceeded those in the actual tunnel fire but
17 adequately reflect maybe a more severe fire that could
18 be fully oxygenated.

19 And we think that we -- well, we know that
20 we amended the report to include a lot of this
21 information. We put tables and charts and that sort
22 of thing. So that's really how we handled that series
23 of comments.

24 The next one I'm going to turn over to
25 Harold, who was the chief modeler. And this addresses

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1 I guess Dr. Weiner's comment on the lead melt.

2 MR. ADKINS: Musical chairs. Again,
3 Harold Adkins from PNNL.

4 One of the comments issued by the ACNW is
5 that within the reports of Baltimore and the analysis,
6 of course, Baltimore and Caldecott tunnel fire
7 studies, we didn't consider lead melt and that not
8 modeling of lead melt could affect the outcome of the
9 analyses in two ways. For one, it would yield
10 non-conservative results from the shielding standpoint
11 if you had lead slump and then an extra-conservative
12 result from the perspective of internal temperatures
13 within the cask.

14 We went ahead and updated. To address
15 this question, we went ahead and updated the model of
16 the LWT and to include the effect of lead melt.

17 What we have here, just to show, I guess,
18 that we have the latent heat effusion taken into
19 account is when you consider different points along
20 the cask as a function of time as it approaches, as we
21 consider locations where there's a little larger lead
22 volume, going across the cask to points where there is
23 also somewhat of an insulative barrier after the
24 neutron shield ruptures, we get an arrangement where
25 basically the temperatures rise, plateau, plateau off,

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1 and then we'll hold until they melt. And then after
2 melting, we'll continue to rise again. And then, of
3 course, on the way down, they'll plateau again and
4 level off until the effects of the lead solidifying
5 have gone away.

6 The net effect of modeling this is we did
7 obtain some margin, minor additional margin, on the
8 peak clad temperatures for the time history. And what
9 you see here is basically the dashed line is
10 neglecting the thermal effects of lead melt and then,
11 of course, including the effects of lead melt. And
12 these are the peak clad temperatures in reference to
13 the ruptured temperature.

14 MEMBER WEINER: Is that peak clad
15 temperature the same one you had in the draft report?

16 MR. ADKINS: Yes. The neglecting right
17 here, the dash.

18 MEMBER WEINER: Yes.

19 MR. ADKINS: Then the solid is, of course,
20 including the lead melt. Average temperatures,
21 there's a little more margin presented, of course.
22 The last one I think we're about 100 degrees
23 different. Here we're about 120 degrees different
24 and, again, with quite a bit of margin to cladding
25 rupture, which is primary containment boundary.

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1 The next effect of the seals is somewhat
2 negligible simply due to the fact that they are
3 outboard on the outside surface of the cask for the
4 most part with the exception of the cask closure lid
5 seals. As you can see here, the plots almost
6 identically overlay.

7 CHAIRMAN RYAN: Excuse me. Could you just
8 refresh us a little bit on the heat load that
9 permeated that curve? I noticed it's a 30-hour curve.

10 MR. ADKINS: Sure, sure. There it is.
11 Let me make sure I understand the question. Mainly
12 you're asking me what is causing the effect for the
13 temperature rise from initiation of the fire --

14 CHAIRMAN RYAN: What were the input
15 assumptions to make the temperature go up and then
16 come back down? Is that a five-hour, six-hour fire or
17 so?

18 MR. ADKINS: That's a 6.67-hour fire, yes.
19 And what it was was the second case that Earl
20 explained that you had questions on regarding the
21 magnitude.

22 CHAIRMAN RYAN: Thanks.

23 MR. ADKINS: And I guess obviously
24 including the lead melt provides a more realistic
25 analysis and demonstrates additional margin with

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1 regards to the fuel cladding. And the report has been
2 modified with the results and conclusions associated
3 with those additional analyses. And a very good
4 comment, Dr. Weiner. Thank you.

5 Next I believe it's Chris Bajwa. Are you
6 back on stage? Thank you.

7 CHAIRMAN RYAN: Thank you.

8 MR. BAJWA: I am Chris Bajwa. I am a
9 thermal reviewer in the Spent Fuel Project Office.
10 And I am going to talk about something that's a little
11 bit outside my area of expertise, but hopefully I can
12 do well with it here.

13 One of the questions that we had from the
14 ACNW was about the assumption that we made that 100
15 percent of the CRUD that can come off the fuel rods
16 was cobalt-60, that that was the main radionuclide
17 constituent of the CRUD. And the question is, is that
18 a valid proximation? And how would it affect the
19 doses in this case of any particular release?

20 We did a little homework on this. And
21 much of the information that we found came from a
22 Sandia report on the estimate of CRUD contribution to
23 shipping cask containment requirements and that Sandia
24 88-1358. This table is actually right out of that
25 particular report.

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1 It turns out that you can see here that
2 for a PWR assembly, which is what we're considering
3 for the NAC LWT, the total activity decreases to about
4 -- these numbers are in the report. And then I'll
5 explain the graph that's there.

6 The total activity for a single PWR
7 assembly decreases to three percent of that at
8 discharge after five years. So this is discharge from
9 a reactor to the spent fuel pool. And five years
10 after that, you have only three percent of your total
11 activity. And then it decreases to one percent after
12 13 years.

13 CHAIRMAN RYAN: Why is total activity up
14 there?

15 MR. BAJWA: Why is total activity?

16 CHAIRMAN RYAN: Yes.

17 MR. BAJWA: Well, in this case, that's
18 just a little background on --

19 CHAIRMAN RYAN: Oh, okay.

20 MR. BAJWA: -- what we're doing with this.
21 And then the cobalt-60 in that accounts for 92 percent
22 of that total activity at 5 years and then 99 percent
23 of that total activity at 8 years.

24 So if you look at the graph here, you see
25 these constituents: cobalt-58, manganese-54, and

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1 cobalt-60. The cobalt-60 is really the bad actor, so
2 to speak. That's the one that you're most concerned
3 with as time goes.

4 CHAIRMAN RYAN: Well, I've got to probe
5 this a little bit if you don't mind.

6 MR. BAJWA: Okay.

7 CHAIRMAN RYAN: This is a whole bunch of
8 other things, like the iron, manganese, magnesium,
9 other things. And it is real easy just to collect
10 them all up, analyze it.

11 I know cobalt is always picked on as the
12 double gamma ray and it's the only one that's
13 transmitted through, but I wonder about that.

14 MR. BAJWA: Okay. Well, part of the other
15 thing, too, that we looked at is the fact that
16 cobalt-60 is in this case a limiting A2 value as well
17 when you're talking about dose. So the A2 value is
18 sufficiently less than some of the other constituents
19 here.

20 CHAIRMAN RYAN: I guess I'm making the
21 point that it's real easy to know the exact inventory
22 and then just calculate the transmission for
23 everything. That way you're not guessing or
24 compromising the inventory.

25 MR. BAJWA: That's true, yes. One of the

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1 things, though, that we have seen in this calculation
2 that we have done, too, is that the increase in the
3 actual release will be very small, even if we did
4 count those other constituents.

5 CHAIRMAN RYAN: Oh, we've got a release
6 now. All bets are off. Cobalt is not important.

7 MR. BAJWA: Cobalt is not important?

8 CHAIRMAN RYAN: It's unimportant.
9 Plutonium, curium, all things --

10 MR. BAJWA: Oh, yes, sure.

11 CHAIRMAN RYAN: What is the magnitude? So
12 if you're looking at an internal exposure, the game is
13 different.

14 MR. EASTON: He's talking about just the
15 release of CRUD.

16 MR. BAJWA: Right, in this case.

17 CHAIRMAN RYAN: Release of CRUD to what?

18 MR. EASTON: To the outside.

19 MR. BAJWA: To the outside.

20 CHAIRMAN RYAN: All bets are off. Cobalt
21 is not important.

22 PARTICIPANT: I think it's a simple
23 release of CRUD without breach --

24 CHAIRMAN RYAN: Without breach?

25 MEMBER WEINER: Without breach of the --

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1 CHAIRMAN RYAN: He said to the outside.
2 So that's a whole different ball game. Cobalt is
3 important. I'm backing up.

4 PARTICIPANT: We'll get to the others.

5 CHAIRMAN RYAN: All right. Fair enough.

6 MR. BAJWA: So consequently, just as
7 another note, for five years of something that's
8 called "five years," the hottest assembly that you
9 could put in any of these casks that we're analyzing.
10 So basically what we have presented here as far as
11 CRUD, we think that it is a reasonable constituent.

12 This is the same thing for BWR assemblies
13 with maximum CRUD spot activities. For BWR assembly,
14 the total activity decreases to 31 percent of that at
15 discharge after 5 years and a one percent after 30
16 years. And in this case, cobalt-60 accounts for 98
17 percent of that activity at 5 years.

18 CHAIRMAN RYAN: Can I ask another dumb
19 question? Why is cesium not on the radar screen here?

20 MR. BAJWA: For the CRUD, I don't believe
21 the cesium --

22 CHAIRMAN RYAN: It's still in the fuel.

23 MR. BAJWA: It's still in the fuel, yes,
24 but for the --

25 CHAIRMAN RYAN: It's about 25 percent of

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1 the total gamma ray transmission if you've got cobalt
2 and cesium.

3 MR. BAJWA: Well, we actually are going to
4 talk about what might come out of the fuel. And then
5 cesium becomes the major player there. But for the
6 CRUD, cobalt-60 is considered to be reasonable for
7 CRUD deposits for --

8 CHAIRMAN RYAN: Again, I hate to be thick,
9 but I'm struggling with release of CRUD. Release of
10 what CRUD to where from where?

11 MR. BAJWA: Basically the CRUD that we're
12 talking about is a deposit that is on the surface of
13 the rods in the fuel assembly.

14 CHAIRMAN RYAN: Right.

15 MR. BAJWA: And so if there is a seal
16 failure, in this case we're basically postulating that
17 because the seals have breached their surface
18 temperature, they go away. So there is a possibility
19 that you could have some release from the internal
20 cavity of the cask into the atmosphere. In this case,
21 what we're taking into account for is --

22 CHAIRMAN RYAN: You just told me it's
23 inside the cask.

24 MR. BAJWA: Inside the cask, right, inside
25 the cask cavity. We're assuming intact fuel.

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1 CHAIRMAN RYAN: Yes.

2 MR. BAJWA: So all we're having --

3 MR. EASTON: Cladding hasn't failed.

4 MR. BAJWA: Right. Cladding hasn't
5 failed.

6 CHAIRMAN RYAN: That's the hook I needed.
7 Okay. Thanks.

8 MR. BAJWA: Okay. And we do go into
9 details as to the additional rationale for the
10 selection of cobalt-60 to represent the CRUD in the
11 report. So this is captured in the report.

12 And I'll let Earl take over and talk about
13 loss of lead shielding.

14 CHAIRMAN RYAN: Thanks.

15 MR. EASTON: Musical chairs here.

16 Again, one of the comments that we got --
17 and this I think came primarily from the Brotherhood
18 of Railroad Engineers and dealt with the protection
19 and the safety of their workers -- was that we did not
20 consider the possibility of loss of lead shielding;
21 that is, the lead exceeding its melting point and
22 somehow slumping because, again, this was not that
23 type of accident that could result in any impacts that
24 would breach the outer containment wall of the cask.
25 So we're just talking about lead.

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1 We went back and consulted primarily with
2 Sandia National Lab, who had done some work in this
3 area. And what we did is we talked to them about a
4 particular model when they had analyzed this issue
5 before. The model is pretty simplistic. It starts
6 out before the fire. This is the lead shielding. And
7 this is the one fuel assembly.

8 What we did as a result of the fire, we
9 let the lead shielding expand. We held the inner wall
10 constant in diameter. We let the lead expand. And we
11 let that push out the outer wall. We didn't take any
12 credit for when it cools down. That outer wall may
13 come back and squeeze the lead back in place.

14 So the volume that the lead expanded to is
15 basically this volume here. So we said that the lead
16 sunk back down when it solidified as sort of a
17 bounding case, and it left a void. Okay? We don't
18 think that there are scenarios that a void would be
19 bigger, larger than that in any particular area. It
20 would be very unlikely.

21 And we did calculations based on the
22 shielding. Sandia did calculations. We did
23 independent calculations. We basically came up with
24 the same answers.

25 What that showed is as a result of the

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1 fire in this void, the dose rate went up at one meter
2 from 14 millirem to hour to about 330. That was still
3 within the regulatory limit that we allow after a
4 hypothetical accident condition of 1,000. There is no
5 regulatory dose rate at the surface, but you can see
6 the surface rate did go up appreciably.

7 CHAIRMAN RYAN: Why are you using
8 sieverts?

9 MR. EASTON: Why what?

10 CHAIRMAN RYAN: Why are you using the
11 International Units? I didn't know the NRC had
12 converted to this.

13 MEMBER WEINER: I think both of them.

14 MR. EASTON: Well, the transportation --

15 CHAIRMAN RYAN: No, not both of them.

16 MR. ADKINS: Here, right here.

17 MEMBER WEINER: Yes. You have millirems
18 per hour and millisieverts per hour.

19 CHAIRMAN RYAN: Oh, it's 1,000 millirem
20 per hour. Okay. Millisieverts. Okay. I'm reading.
21 Sorry. The other challenge is, how can you have five
22 significant digits? Please stop doing that to
23 yourselves.

24 MR. ADKINS: You got me on that one. I
25 surrender on that.

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1 (Laughter.)

2 MEMBER WEINER: What did you use to
3 calculate the shielding? Did you use microshield or
4 --

5 MR. EASTON: Yes, microshield.

6 MEMBER WEINER: Okay.

7 MR. EASTON: Some of your I guess
8 colleagues at Sandia use microshield to help.

9 MEMBER WEINER: Yes.

10 MR. EASTON: And we reran all the
11 calculations to make sure. And we worked with Doug
12 Ammerman to make sure that the structural modeling is
13 internal.

14 And, again, this chart, these diagrams,
15 are included in the report now in a discussion. So we
16 believe -- and, again, this is --

17 MEMBER WEINER: Excuse me, Earl. Did you
18 include the microshield model in the report?

19 MR. EASTON: You mean the actual data from
20 the --

21 MEMBER WEINER: Yes, the actual. Yes.

22 MR. EASTON: No. We just basically put
23 these tables in so we were in these calculations. And
24 we didn't actually.

25 So we believe that even for the case of

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1 lead melt and resolidification, that the doses would
2 remain below the regulatory limits for hypothetical
3 accident conditioned under Part 71. And we have
4 revised the report to reflect that.

5 We do appreciate that comment. We think
6 it was a good comment. We had focused only on the
7 releases. And we think that was, again, a very good
8 comment. And that made the report much more complete.

9 Okay. Chris is going to come back up and
10 handle this tough one with the cesium, and I'll be
11 here to help him.

12 MR. BAJWA: I always appreciate Earl's
13 help on these things.

14 All right. So we're going to talk about
15 the effects of damage and high burn-up fuel. In the
16 original studies, we didn't deal with either high
17 burn-up or damaged fuel.

18 We did have several comments on this, both
19 from the public and from the industry. As we
20 presented the results in different industry forums,
21 the question came up. And so we decided that we
22 definitely needed to take a look at this.

23 The releases that we're talking about are
24 actually from the NAC LWT cask, which is in this case
25 carrying a single PWR assembly. And the reason that

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1 we don't consider damaged fuel or high burn-up in the
2 other casks that we looked at, the TransNuclear 68 and
3 the HighStar 100, the TransNuclear 68 is not licensed
4 to carry damaged fuel. So it would not have a payload
5 that would include damaged fuel.

6 The HighStar 100 has an inner canister
7 that is welded. And that in our analysis thermally
8 did not fail. So there is nothing available for
9 release from the HighStar 100, even if it was carrying
10 damaged fuel. So that's why we're only looking at the
11 NAC LWT here.

12 We went to NUREG 6672, which has been
13 mentioned a couple of times. And in that document,
14 they actually have an analysis that is done for truck
15 cask in a severe fire. And they looked at the
16 releases that could come from damaged fuel.

17 The fuel that they used in their analysis
18 was high burn-up. It was 60 GWD per MTU. And they
19 assumed that there was a 100 percent burst of all the
20 fuel rods and that the temperatures were high enough
21 to volatilize cesium.

22 So this is essentially worst-case scenario
23 in terms of they didn't project that only a percentage
24 of the fuel was failed. They said all of it was
25 failed.

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1 And so the release fraction that's
2 calculated in that document for cesium-137, which we
3 believe is the bad actor here, for severe fires is 100
4 percent rod burst at 1.7 times 10^{-5} . That particular
5 release fraction is a number based on essentially a
6 seven-factor formula.

7 And it includes the fraction of cesium
8 present in the fuel assembly, in this case a single
9 PWR fuel assembly, that's available for release, the
10 fraction that plates out. So they assume that some of
11 it does plate out before it gets out or is deposited
12 on the internal cavity of the cask as well as the
13 differential pressure between the cask cavity and the
14 atmosphere and to allow the release.

15 EXECUTIVE DIRECTOR LARKINS: So what
16 fraction of the cesium inventory does this represent?

17 MR. BAJWA: I think the number is -- well,
18 it's 1.7 times 10^{-5} is the release fraction for
19 cesium-137. So that's the fraction that you multiply
20 by the total activity of the cesium in that PWR
21 assembly to get the release, which in this case is 1.4
22 curies. So you take --

23 EXECUTIVE DIRECTOR LARKINS: Okay.

24 MR. BAJWA: It's in that formula. You
25 take the release fraction. You multiply it by the

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1 total activity that you have for cesium-137 for a
2 single PWR assembly. And that's how you determine
3 what the release is.

4 MEMBER WEINER: What did you assume for
5 the internal temperature of the cask to get plate out
6 at the walls? Because if the internal temperature of
7 the cask is the same as the external temperature, I
8 don't see where anything is going to plate out. It
9 has to be a little cooler.

10 So what kind of assumptions were made for
11 the internal cask temperature? Was that during the
12 seven hours of the fire the internal temperature
13 hadn't reached the external temperature or what?

14 MR. BAJWA: In this case the calculation
15 I think assumes a cooler temperature allow for the
16 plate out. So I don't know exactly what -- it might
17 have been assumed that the internal temperature is at
18 the temperature of the fuel rods bursting, which I
19 believe is 750 C.

20 And then the external temperature is the
21 fire. And the interior would definitely be cooler to
22 allow for the mechanism. Otherwise you wouldn't take
23 credit for it. So that's a good point.

24 CHAIRMAN RYAN: Did you do any follow-up
25 analysis with the 1.4 curies in terms of exposure

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1 scenario to individuals or how did you handle that
2 1.4-curie release?

3 MR. BAJWA: Well, basically the 1.4 curies
4 is 10 times less than the A2 for cesium-137. And the
5 A2 obviously is based on dose. So in this case, we
6 are focused on the A2 value.

7 CHAIRMAN RYAN: So A2 was just the metric
8 you stopped at?

9 MR. BAJWA: Pretty much.

10 CHAIRMAN RYAN: Okay.

11 MR. BAJWA: So the potential releases for
12 damaged or high burn-up fuel are less than the
13 regulatory limits. In this case, the A2 value is our
14 benchmark that was established for transport safety.

15 And the report actually includes a new
16 section that details this evaluation, goes into the
17 calculation, explains the seven-factor formula and
18 whatnot.

19 MEMBER WEINER: What happens if you don't
20 assume plate out?

21 MR. BAJWA: Your release would increase.

22 MEMBER WEINER: Yes. Did you do that
23 quantitatively, look at that?

24 MR. BAJWA: We did not do a sensitivity on
25 plate out.

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1 MEMBER WEINER: Okay.

2 MR. BAJWA: We just assumed that that is
3 a reasonable mechanism. So we didn't look at that.

4 CHAIRMAN RYAN: Did you say you have got
5 a margin of about a factor of ten between?

6 MR. BAJWA: Yes, the A2 for cesium-137 is
7 14, 14 curies.

8 CHAIRMAN RYAN: Right.

9 MR. BAJWA: So Earl will talk about
10 performance with cask seals.

11 MR. EASTON: And, again, this whole issue
12 of cesium is more fully described in the 6672, which
13 is based on experimental studies, the vapor pressure
14 on various cesium salts, temperatures and that sort of
15 thing. So we just basically adapted that.

16 One of the comments we got is about the
17 failure of seals. And, again, I would like to
18 emphasize that we didn't take any credit for any of
19 the seals in calculating these release fractions. We
20 really took credit for the small clearances between
21 the lid and the cask body.

22 And so we didn't really go too much into
23 a discussion of cask seals, although we have talked to
24 research about doing some additional confirmatory
25 research, maybe about looking at how seals behave in

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1 severe fires or how those clearances behave in severe
2 fires.

3 So basically we just pointed out again
4 that we didn't take any credit for seals. One might
5 ask, why are the seals really there if you don't take
6 any credit?

7 Well, remember when you ship under normal
8 conditions, the release rate is based on the very
9 strict health physics model, where you have to be in
10 close proximity for a year and you count up everything
11 over that year. So it has had a very, very tight
12 release rate. And to get that, you have to have a
13 very, very sensitive seal. And you have to have a
14 strong clamping force.

15 So a lot of the function of the seal is to
16 make sure you comply with normal conditions of
17 transportation. We had that extra margin to extend it
18 out to hypothetical accident conditions, but a lot of
19 the containment is providing and keeping the cladding
20 intact and keeping that clearance small and fast. And
21 we did add some language to the report.

22 I just wanted to emphasize here that we
23 only got one comment on the Caldecott tunnel fire.
24 And that comment focused on -- I guess we got a
25 comment from an individual that was with the

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1 California Highway Patrol and commented that the
2 report in NTSB was different and could we reconcile
3 that.

4 And I think we said, "Well, we're going to
5 steer clear of reconciling that" and tried to depict
6 the accident as accurately as we could and with the
7 bounding-type analysis.

8 So that was the only comment, but many of
9 the comments we got on the Baltimore tunnel fire have
10 applicability to the Caldecott. So we looked at all
11 the BTF comments and made changes in the Caldecott as
12 appropriate. Okay? We just assumed they were
13 comments also on the Caldecott.

14 CHAIRMAN RYAN: Were there any differences
15 in the CHP versus the NTSB report as well?

16 MR. EASTON: Do you want to get into that?

17 MR. BAJWA: Okay. All we really know
18 because we didn't really pursue it is that there were
19 differences in how the accident actually happened.
20 And what we were told by the individual from the CHP
21 was that NTSB admitted that -- well, NTSB never
22 admitted that there were any differences. And they
23 stuck by what they thought the accident, as described
24 in their report -- how it happened. And CHP just
25 thought that their version was more accurate.

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1 CHAIRMAN RYAN: What are the differences,
2 I mean, in terms of --

3 MR. BAJWA: We never asked what the
4 differences were.

5 MR. EASTON: I think they were more
6 focused on the sequence of the accident --

7 MR. BAJWA: Exactly.

8 MR. EASTON: -- and cause, the root cause.

9 MR. BAJWA: Right, not within --

10 CHAIRMAN RYAN: That's really the focus of
11 my question, some assumption that would change what
12 you assumed the analysis. I mean, that's a weakness,
13 but --

14 MR. BAJWA: I don't think it --

15 CHAIRMAN RYAN: The differences that you
16 talked about don't have an effect on your assumptions.
17 I assume that you took these differences of that
18 context into --

19 MR. BAJWA: I think when we just described
20 how the accident happened, somebody said, "Well, it
21 may have happened a little differently, but the
22 consequences are the same." So we didn't get involved
23 in --

24 CHAIRMAN RYAN: And you said that in your
25 report?

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1 MR. BAJWA: Well, we can --

2 MR. EASTON: I think we said it in our --

3 CHAIRMAN RYAN: I think it is important.

4 I'm just trying to think about how to close this up.

5 If you say, "Well, there might have been slight

6 differences in the sequencing, but in terms of your

7 assumptions for impact analysis that didn't have any

8 bearing, that's important for you to make an

9 assessment on that.

10 It sounds like you have done that. You

11 ought to just say it.

12 MR. EASTON: Yes. I think we're going to

13 say it in appendix G, which is attached.

14 CHAIRMAN RYAN: Okay.

15 MEMBER CLARKE: Earl, while we're on that,

16 could I ask a question about the heavy carbon fuel?

17 You have on slide 6, I guess, 7, tripropylene, a

18 specific hydrocarbon fuel. Does that matter? I mean,

19 have you bounded the case? Obviously it could be

20 other hydrocarbon fuels.

21 MR. EASTON: Yes. I mean, I --

22 MEMBER CLARKE: Were they different in

23 these situations? Is this actually the fuel that was

24 in one of the --

25 MR. EASTON: No.

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1 MEMBER CLARKE: Because you have a --

2 MR. EASTON: This was actually the fuel.

3 So a lot of the details were based on that fuel, but

4 --

5 MEMBER CLARKE: For both fires?

6 MR. EASTON: The fire for the Caldecott
7 was gasoline.

8 MEMBER CLARKE: Sorry. I guess what I'm
9 asking is your analysis doesn't really matter what the
10 fuel is. You've --

11 MR. EASTON: We were told given all the
12 parameters, that, you know, the exact nature of the
13 fuel was not all that dominant. We were told that.

14 MEMBER CLARKE: Yes. I just wanted to see
15 how you --

16 MR. ADKINS: The flammability rating of
17 the tripropylene is directly parallel to that of the
18 fuel that was involved in the Caldecott tunnel fires.

19 MEMBER CLARKE: But other hotter fuels
20 that could change your analysis or have you bounded
21 that?

22 MR. EASTON: I think these are typical of
23 -- this is like no mean. You know, there are like all
24 different chains. I think this is the typical mean
25 for a hydrocarbon. I think it would be tweaking and

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1 not really that much.

2 MEMBER CLARKE: Not that important to the
3 analysis.

4 MR. EASTON: I'm a chemical engineer. So
5 I didn't trust them. I went back and pulled the
6 numbers.

7 CHAIRMAN RYAN: That's all reflected in
8 your report?

9 MR. EASTON: No, not this. This is my --

10 MEMBER CLARKE: I just wanted to probe you
11 on that because you were mentioning a specific fuel
12 and a specific fire.

13 MR. EASTON: Do we have a specific
14 argument about generalizing the hydrocarbon fuel? I
15 know the NIST report.

16 MR. BAJWA: Basically what we understand
17 from NIST -- and Dr. Kevin McGrattan did the original
18 FDS models. In fact, he's just next door in an ACRS
19 meeting.

20 In general, hydrocarbons behave very, very
21 similar when you put them in full fire situations. So
22 the differences that would be between tripropylene and
23 some of the other hydrocarbons that could be
24 transported on a rail or would be transported on a
25 rail would not change the numbers very much at all.

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1 MEMBER CLARKE: I guess what I am
2 suggesting is you might want to put a little bit about
3 that in your report.

4 MR. BAJWA: Okay. That is a good
5 question.

6 MEMBER WEINER: As a matter of fact, all
7 you will get, the biggest difference you would get,
8 would be the heat of bond rupture from the mother
9 carbon-hydrogen bond during another couple of those.
10 And that would be lost in your other heat loss.

11 MEMBER CLARKE: I think that probably
12 merits an explanation.

13 MR. BAJWA: Okay.

14 MEMBER CLARKE: So we'll --

15 MEMBER HINZE: Let me ask a related
16 question if I might relate to the location of the
17 fire. If you look at a petroleum tank farm, what you
18 see are the tanks. And each one will have a dike
19 around in case there is a fire, the flow the petroleum
20 product is confined to within the dike.

21 Have you considered the possibility of a
22 rupture of a tank and then the leak-out, the run-out?
23 And so that the fire will actually be in greater
24 proximity to the spent nuclear fuel.

25 MR. EASTON: You mean like a stationary

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1 tank?

2 MEMBER HINZE: Yes. Well, you have the
3 tank rupture. And if there is insufficient oxygen,
4 you won't have or you will have run-out of the fuel.
5 And that fuel could get much closer to your canister.
6 And, therefore, your temperatures would be higher.
7 Have you considered that?

8 MR. EASTON: I don't know if we've done
9 that exactly analysis of a stationary tank rupturing.
10 We have gone back and looked at all the train
11 accidents. And some of those involved tank cars,
12 where you have rupture and run-out.

13 And what we have done -- I guess I had a
14 couple of different graphs here. We have actually
15 gone back in some of these accidents and taken the
16 graphics of how the tank cars end up. And you usually
17 always get a buffer car the way that these things
18 accordion.

19 In every accident we see, you get a buffer
20 car between the actual tank car in the spent fuel
21 casks. So if it's burning at the site of the tank,
22 you usually have something intervening.

23 MEMBER HINZE: But the run-off could still
24 go underneath the car.

25 MR. EASTON: It could, but --

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1 MEMBER HINZE: It would move beyond the
2 buffer car.

3 MR. EASTON: But you would have to get a
4 pretty fully engulfing fire under the whole tank car
5 because these are pretty big heat sinks if I'm
6 following.

7 MEMBER HINZE: Yes, I understand.

8 MR. EASTON: And, you know --

9 MEMBER HINZE: But you also get run-off.
10 And that fire could be in much greater proximity than
11 you're assuming by this buffer car.

12 MR. EASTON: Yes. Well, this again is
13 just focused on tunnels and focused on rail accidents.

14 MEMBER HINZE: Which would be even more
15 confining. It would confine the run-off.

16 MR. EASTON: Well --

17 MR. ADKINS: One of the things that I
18 think might be prudent to be mentioned is if you did
19 have migration of the fuel, potentially what you could
20 get is a larger pool.

21 And when we did some sensitivity
22 evaluations, you know, one of the things that worked
23 against us is the fact that the fire did last seven
24 hours because these casks have a tremendous amount of
25 thermal inertia.

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1 So if the fuel burns up abruptly, it's
2 actually less damaging to the actual cask and the
3 contents itself. So if the fuel were to migrate, you
4 would have a high potential that the fuel would be
5 potentially larger and yield a lesser effect than what
6 we have studied here.

7 Pool, the pool size that was selected in
8 a square area as well, there was a lot of thought, I
9 guess, regarding the selection of that particular
10 square area to work against us from the standpoint of
11 working with the time constant associated with the
12 cask.

13 MEMBER HINZE: But did you also take into
14 consideration the proximity of the fire, then?

15 MR. EASTON: Yes. And, in fact, I'm glad
16 we're back on that. There were a couple -- you know,
17 Kevin McGrattan gave us quite a bit of data, as you
18 would imagine, for the particular fire.

19 And Chris and I actually went through and
20 looked for, prior to the buffer car discussion looked
21 for where we were going to witness one of the higher
22 heat fluxes associated with the location of where the
23 fuel would be and where the cask could potentially be.

24 Oddly enough, with the exception of being
25 directly in the fuel pool, by the way the flaming

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1 product migrates and the way the tunnel is oriented
2 and the way the cask was potentially situated, at
3 least the rail car location, the 20-meter location was
4 actually one of the worst where we witnessed one of
5 the highest heat fluxes just due to the fact that the
6 combustion process was quite a bit more efficient at
7 that particular location.

8 MEMBER HINZE: Does that get into the
9 report, then, that thinking?

10 MR. EASTON: In a sense, yes, from the
11 regard that we have touched on it. And also a lot of
12 these details have been included in the NIST report.

13 MEMBER WEINER: What happens in the event
14 of a dual track tunnel, where you could actually have
15 -- I noticed that was one of the comments, but if you
16 have a tank car on the other track, so to speak, then
17 you don't have the accordion.

18 MR. EASTON: We're getting to that, yes,
19 --

20 MEMBER WEINER: Okay. If that's --

21 MR. EASTON: -- unless you want me to give
22 you the answer now.

23 (Laughter.)

24 MEMBER WEINER: Well, if you're getting to
25 that, I'll wait. It's tough, but I'll wait.

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1 MEMBER HINZE: We suckered you into that
2 one, didn't we?

3 (Laughter.)

4 MR. EASTON: We are going to get right
5 into it. Okay?

6 MEMBER WEINER: Okay.

7 MR. EASTON: And, again, we're trying to
8 put this again in some risk perspective. As you know,
9 when Kevin Crowley came to brief you on this, he said
10 that basically the outstanding safety issue if there
11 was one was long-duration fires. And so we went back,
12 and we looked at long-duration fires, fully engulfing
13 fires. And the tunnel was a component of that.

14 The Baltimore tunnel fire, the Caldecott
15 tunnel fire, our general survey of FRA accident data,
16 and some actions we have taken with the Association of
17 American Railroads all are geared towards addressing
18 this report. So that's really how we're going to use
19 the Baltimore tunnel fire as one piece of data in the
20 end that we're going to use to address the NAS
21 conclusions on long-duration fires.

22 I hope I don't bore you. Some of you have
23 probably heard some of this a little bit before. I'll
24 go through it real quick. We went through 30 years of
25 data, 21 billion train miles. In that time, there had

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1 been 1,726 releases of hazmat from vapor to multiple
2 tank cars. We went and assessed those accident
3 reports. Based on that assessment, we think we have
4 less than ten where there have been severe fires.

5 MEMBER WEINER: Could you go back to the
6 preceding slides, then? You actually have 11
7 significant figures on number of train miles.

8 MR. EASTON: I just added up the data from
9 FRA.

10 (Laughter.)

11 CHAIRMAN RYAN: That's actual addition.
12 That's fine.

13 MEMBER WEINER: Yes, that's fine.

14 CHAIRMAN RYAN: In relation to where we're
15 going, it's not. I heard you say you added up the
16 actual figures.

17 MR. EASTON: Right.

18 CHAIRMAN RYAN: I'm okay with it.

19 MR. EASTON: Approximately 21 billion
20 miles. Okay.

21 Now, real quickly, to set up the answer to
22 Ruth's question, when you look at these rail accidents
23 -- and these are events per million miles -- you see
24 that railroads in general have become safer, but this
25 purple area, most of the accidents are derailments of

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1 single trains. Okay? Very few collisions. And
2 others, as you know, in rail yards and that sort of
3 thing.

4 Why is that important? Well, in
5 collisions, you usually don't get long-duration fires.
6 And the reason why is trains have regulations that if
7 they're long enough, the first hazmat car has to be
8 like six cars back from this end and six cars. And
9 trains usually collide in the front and the back.

10 When you side swipe, you only usually get
11 one or two cars at most involved. It turns out that
12 most times that you have a fire, it's a train with 10
13 or 12 cars going off the track and getting jumbled up.

14 Okay. The other point, again, this is
15 accidents. These are total number of accidents now
16 because we're in rail yards. It's hard to do by
17 miles. Half of the accidents happen in rail yards,
18 and half are outside rail yards.

19 So of all of these accident that we looked
20 at, again, looking at the approximately 21 billion
21 miles of train travel, most were derailments of a
22 single train. We could only find one really severe
23 fire that occurred in the tunnel. We have been
24 studying that for five years now.

25 It is likely that in all of these

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1 accidents, what we have found is that there haven't
2 been fully engulfing long-term fire that fully
3 engulfed a cask because either the placement of a
4 spent fuel cask, where that would have ended up, we
5 have gone back and actually mapped the location of the
6 cars and numbered them and say, "What if you picked
7 spent fuel?"; that sort of thing.

8 The nature of the flammable material, a
9 lot of these are flammable gases which either BLEVE
10 into a big fireball and it's over very quickly or burn
11 and they burn back to the tank car and they let those
12 burn for days and evacuate whole towns for days and
13 they won't let anybody back into those towns until
14 those tank cars are empty because they don't want an
15 explosion.

16 So it's really not the fire danger. It's
17 often an explosion danger. And the most severe parts
18 of the fires are over very quickly. And in almost
19 every case, we have found that emergency response
20 people were there very quickly. Okay?

21 Now, do these three factors work well in
22 tunnels? Well, you can't get in a tunnel to do
23 emergency response. The nature of the flammable
24 things, the gas just eats up the tunnel. And the
25 placement of spent fuel casks, well, I don't think

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1 that's too bad. So maybe tunnels are a little unique.
2 That is what we found out.

3 So is there a simple fix perhaps to all of
4 this? Well, most big shipping campaigns we think,
5 like DOE, will use dedicated trains. So if you derail
6 a single dedicated train with no flammable liquid, you
7 probably have pretty much eliminated that.

8 We went to the Association of American
9 Railroads, and we said, "What happens if you have
10 flammable liquids in a tunnel with spent fuel at the
11 same time? Is there a way that we could put on
12 operational controls on the railroad to prohibit
13 them?"

14 And we did that because we're not the
15 experts because if we prohibit shipment, we might make
16 something else less safe, you know. So we said,
17 "You're the experts. Can you do that?"

18 We approached them in March. In July they
19 changed their rules. The rule says that when you have
20 a tunnel with two tracks, single bore, you're not
21 allowed to have a train with run-over liquids and
22 spent fuel at the same time. The exact wording is
23 given in one of the backup slides. Okay? That's
24 OT-55, revision I.

25 And we think with that, that is about the

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1 best operational control you can have to eliminate
2 tunnel fire. So we think dedicated train tunnel fires
3 takes what is really a low probability event as close
4 to zero as we can practicably achieve, as close to
5 zero as we can practicably achieve.

6 So that's what really came out of this
7 study and the NAS study is we do have an operational
8 control through the Association of American Railroads
9 that would prohibit that. They're probably less than
10 ten of these type tunnels in the whole country; that
11 is, double tracks in the door. And so they said it
12 was not an undue --

13 CHAIRMAN RYAN: Really? There are only
14 ten like that in the country.

15 MEMBER WEINER: Most of them have dual
16 doors.

17 CHAIRMAN RYAN: I understand.

18 MR. EASTON: There were a number, a higher
19 number, at one time, but most all of them had the
20 second track removed and the other track located in
21 the center to accommodate higher cargo.

22 CHAIRMAN RYAN: Interesting.

23 MR. EASTON: And where you have a lot of
24 traffic, the trend has been to do a separate door.

25 CHAIRMAN RYAN: This is just an

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1 off-the-wall question, but, I mean, are any of these
2 last ten dual tracks anywhere near where spent fuel
3 would be shipped?

4 MR. EASTON: That I don't know.

5 CHAIRMAN RYAN: If they're all in North
6 Dakota, it's not a big deal for anybody.

7 MR. EASTON: I think there may be one or
8 two located in the Northeast, but generally they route
9 around them.

10 CHAIRMAN RYAN: Interesting.

11 EXECUTIVE DIRECTOR LARKINS: I just have
12 a general question. You said half of these occur in
13 the train yards. Have any of these gone from simple
14 deprivations to detonations or have they had any more
15 energetic types of events other than just the simple
16 pool fire?

17 MR. EASTON: Yes. And I won't bore you,
18 but I have a whole presentation on that with maps and
19 rail yards and everything. There have been a few
20 where initially you have BLEVEs, you have a puncture
21 and you have it explode. And then usually it catches
22 some sort of cargo on fire, like, you know, if you
23 have tires, they burn, but they're not fully engulfing
24 as with respect to a spent fuel car. They are with
25 respect to the tires or the paper. And we have gone

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1 back to one in Akron, Ohio, where you had a BLEVE.

2 The best thing for spent fuel casks is to
3 probably go ahead and let the thing explode, but
4 that's not the best for a lot of other cases. So
5 primarily how these accidents work is you either get
6 a puncture and you get a muted explosion or you get a
7 fire that burns with some intensity and then burns
8 back to the tank car.

9 There's one famous example, Weywauaga,
10 Wisconsin, where they had an evacuation for 15 days.
11 And it burned for 15 days. But there are cases where
12 the firemen had to go back and relight the fires
13 because some of the fires were going out.

14 They were trying to vent the tanks,
15 instead of actually going back and relighting. And I
16 pictured them standing on top of the tank cars
17 relighting them. And this is one that many critics
18 cite, and they evacuated for 15 days, but after about
19 the first 3 hours, the fire is under control. And
20 these are all what they call pressure fires, and they
21 come back.

22 But they evacuated that town for 15 days.
23 By the eighth day, you had people standing on the tank
24 cars with pipes out fighting them. So, anyway --

25 MEMBER WEINER: Can you go back a second?

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1 Okay. The AAR has made a rule. And, admittedly, even
2 the situation where this could occur isn't going to
3 happen very often.

4 How can you be assured that the trains are
5 going to abide by the rules? It's one thing to make
6 a rule. We all know that the rules are broken now and
7 again.

8 MR. EASTON: That's a very good question.
9 We asked that question. First we approached the
10 Federal Railroad Administration to see if they were
11 interested in regulation.

12 MEMBER WEINER: Yes. And they said no?

13 MR. EASTON: And they said no. The best
14 way to do it, the most efficient way to do it, really,
15 the rules that are as ironclad as you can get are the
16 circulars that AAR put out because they control the
17 five or six major railroads. And it's the top
18 executives that agreed to the rules. And these are
19 pretty much the law of the land.

20 Now, we take that on faith from the
21 Federal Railroad Administration a little bit, but they
22 said, you know, it's in their interest to do it. I've
23 heard that before, too. And since there are only
24 about ten of these tunnels, it's not a big burden.
25 They've been sensitized to this.

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1 In the circular, it says the NRC has
2 requested that this action be taken. And so the
3 railroads know that we have requested it, we feel
4 serious about it. But it does not have the force of
5 law or regulation, but it's the most expedient way we
6 could go. And we have asked the Federal Rail, who is
7 in charge of this area. They did vent this, like I
8 say, with all the major railroads. They did change
9 it.

10 MEMBER HINZE: Earl, how much monitoring
11 would there be by the NRC, DOE, et cetera, in the
12 transport of these special trains, these dedicated
13 trains, to eliminate the kind of possibility that this
14 is bringing out?

15 MR. EASTON: My experience has been there
16 will normally be quite a bit of monitoring of these.
17 States have stopped trains to inspect them, to go to
18 that length. The Federal Railroad Administration has
19 special protocols in to double check equipment on a
20 more frequent basis, double check tracks.

21 I don't know if this has made it in
22 because this is July 16th, but we have made all the
23 states aware of this. And in the end, it will be up
24 to the railroads to apply the circular.

25 Since it's not a regulation, it would be

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1 up to then the states to I guess use the bully pulpit
2 to really make this happen or another important thing,
3 since there are so few of these and states -- this is
4 for Yucca Mountains -- states are now actively engaged
5 and DOE in deciding the routes, the preferred routes,
6 as you know. And they may very well decide to use
7 this as a factor.

8 MEMBER WEINER: Yes. Let me correct one
9 thing, which DOE keeps bringing up at these meetings.
10 The states will not decide the routes. DOE will
11 decide the routes.

12 MR. EASTON: That's correct.

13 MEMBER WEINER: And the states can say
14 that they have preferred routes. And, actually, when
15 you look at it, if you look at most of these routes,
16 which go across the country, there are very few
17 choices. At most through any particular state or
18 region, there are three possible, three, four at the
19 outside possible routes that you can take because they
20 have to connect.

21 MR. EASTON: Right.

22 MEMBER WEINER: So I did want to correct
23 that.

24 MR. EASTON: And you're right. States
25 don't pick the routes. DOE and shippers pick the

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1 routes, railroads. They are sensitive. And they are
2 doing studies now in an advisory capacity to DOE.
3 These are the routes.

4 MEMBER WEINER: These are routes.

5 MR. EASTON: A lot of them in the Midwest
6 don't go through many tunnels. A lot of the tunnels
7 in the mountains in the west are single bore. And I
8 think you will just find a very few choke points at
9 dual. And I think that they will consider that in
10 routing. That is probably the best and quickest we
11 could do to even reduce what I want to emphasize is a
12 very small risk.

13 We didn't find any cases of fully
14 engulfing fire. Our conclusions on the tunnel fire
15 are that it's relatively benign. But, despite that,
16 if there's a simple rule that you can sensitize people
17 to, then we think it basically eliminates it.

18 CHAIRMAN RYAN: Okay. Are there any other
19 questions?

20 MEMBER WEINER: No.

21 VICE CHAIRMAN CROFF: Yes. Can I take you
22 back to slide 11? I've got a question about that
23 first bullet. Are water mains commonly in these
24 tunnels? And what would have happened if there wasn't
25 a water main to the accident?

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1 MR. EASTON: I don't know that they're
2 common in this tunnel. It just happened to be
3 collocated with the water main. It basically put out
4 the fire. If we wanted to model the Baltimore tunnel
5 fire correctly, we would have modeled a three-hour
6 fire, but we didn't want to take any credit for the
7 water main. That's why we --

8 VICE CHAIRMAN CROFF: Oh, so your scenario
9 didn't take any credit for that?

10 MR. EASTON: No, sir. That's just
11 historical. Sorry. That's just historical data.
12 That's the way it happened: something major
13 intervening that was over primarily in three hours.
14 But we went and said, what would it take to consume
15 the whole tank there?

16 VICE CHAIRMAN CROFF: The second question,
17 the buffer cars that are normally used, are they
18 normally box cars or flat cars? The picture you
19 showed I think showed flat cars I remember.

20 MR. EASTON: If I remember, I think it was
21 actually -- well, I think the buffer cars are actually
22 the box cars in this picture. See, what you are
23 looking at, the spent fuel cask sits in the middle of
24 a long car. So that space there is just the end of
25 that flat car.

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1 VICE CHAIRMAN CROFF: I was seeing
2 something else there.

3 MR. EASTON: But if your question is it
4 could be either, it could be a flat car, but, then
5 again, that holds basically -- it would be a long
6 space. But the space between the box car and the --

7 VICE CHAIRMAN CROFF: The reason for the
8 question is the overriding, cars overriding, issue.
9 It seems a flat car would be a bit easier to override.

10 MR. EASTON: Yes because I guess a flat
11 car with the ends might come up to where that arrow
12 says on eight feet maybe, you know, cut that off,
13 something like that, because, you know, you usually
14 have ends on them.

15 VICE CHAIRMAN CROFF: Yes.

16 MR. EASTON: And you could conceivably get
17 a tank car up over that, but it would be -- you know,
18 these are very heavy. And you sort of have to angle
19 it right. Again, this was not a collision. It didn't
20 have much force.

21 And, again, these go into a coupler. And
22 those couplers have been strengthened within the last
23 couple of years to not let that fall apart. The most
24 likely mode is now, from what FRA tells me, that the
25 couplers don't give, but the rail cars just fall over

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1 together and try to remain coupled. Really, that's
2 one of the focuses: to keep those couplers together.

3 One of the biggest cause of accidents up
4 until that time was the couplers coming apart and
5 puncturing. So they worked on keeping those
6 connections as strong as they can.

7 CHAIRMAN RYAN: All set?

8 MEMBER WEINER: Jim?

9 MEMBER CLARKE: I just think it's
10 important in the casks to clarify that you have looked
11 at the identity of the different hydrocarbon fuels and
12 you get to bond to that situation or your analysis is
13 such that it's insignificant just to show --

14 MR. EASTON: We'll put in that. Good
15 comment. We'll put in that.

16 MEMBER WEINER: I've got three questions.
17 If it's true that in the model that you have you never
18 really get to the clad rupture temperature, what about
19 damaged fuel? What would you significantly rupture,
20 get into the actual fuel if you had damaged fuel to
21 begin with?

22 MR. EASTON: If you had damaged fuel to
23 begin with, I'm assuming that most of the krypton and
24 all of that is gone, right?

25 MEMBER WEINER: Yes.

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1 MR. EASTON: And so the cesium, rather
2 than being volatile if you're not talking the
3 temperatures, is more of a particulate. And it's just
4 trying to get particulate out through a closure. Is
5 that where you are?

6 MEMBER WEINER: I'm just asking the
7 question. The cesium would be cesium chloride, --

8 MR. EASTON: Right.

9 MEMBER WEINER: -- no matter where it is.
10 And I was just wondering if you had -- well, let's
11 take the case of de-clad fuel.

12 MR. EASTON: Right.

13 MEMBER WEINER: What would happen at these
14 temperatures?

15 CHAIRMAN RYAN: De-clad fuel?

16 MEMBER WEINER: Well, they have some that
17 don't -- I know.

18 MR. EASTON: Chopped-up fuel?

19 MEMBER WEINER: Yes, chopped-up fuel.

20 CHAIRMAN RYAN: That's not de-clad,
21 though.

22 MR. EASTON: Well, yes. And I think
23 probably 6672 addressees that to some extent.

24 MEMBER WEINER: If they do, I apparently
25 don't remember.

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1 MR. EASTON: The reason we chose the
2 particular analogy or reference to 6672 is because we
3 thought cesium becomes a bad actor if it's at a higher
4 temperature and you have a vapor temperature and you
5 have something that can get through small clearances.
6 And I think at lower temperatures, you don't have
7 that. What is the melting point for cesium? It's up
8 over 1,000 degrees for most cesium. Vapor pressure is
9 pretty low, too.

10 That is what this model is really based
11 on, the vapor pressure of cesium. I think if you had
12 lower temperatures, it works in your favor. You're
13 just trying to get the particulates out. It's hard to
14 get through tight clearances. But we didn't really
15 look at that.

16 MEMBER WEINER: Could you have a pool fire
17 in the tunnel? How likely is that?

18 MR. EASTON: A pool fire in the tunnel?

19 MEMBER WEINER: A pool fire in the tunnel.

20 MR. EASTON: I think it's more likely to
21 have a pool fire in the tunnel than not in the tunnel
22 because outside the beds are generally raised and
23 there's poor substrate. Conceivably you could have a
24 concrete floor or something like that.

25 But when you think about what it would

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1 take for a fully engulfing fire for a long period of
2 time -- this burns about what, 11 inches per hour? So
3 if you wanted to have a fire, you would need 70 inches
4 of fuel. And so you have to feed that pool, you know,
5 at that rate to keep the pool right under that cask.

6 Most of these tunnels have what, a three
7 percent grade? So you dump all the fuel out. And
8 it's going to spread over a wide area. And that area
9 will determine how fast it burns. And if it burns up
10 faster, you know, away from the cask, it probably gets
11 you more attuned to what we analyzed with the
12 radiation coming from the tunnel.

13 So we didn't see that as a particular
14 issue because this was a low probability that we
15 thought that would happen. That is, it runs out that
16 small hole and it goes all the way down 60 feet and
17 forms a pool. And it's just that right configuration
18 for that period of time.

19 MEMBER WEINER: Finally, the test sequence
20 in 71.73, you think that that is adequate to cover
21 this particular concern? I know that question has
22 been raised from time to time in the past.

23 MR. EASTON: Well, my opinion is yes
24 because we did an analysis for a much longer time than
25 what that test is, although it's not the exact

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1 condition. And we didn't find that you really get
2 significant releases.

3 So I think any time you ask if the
4 regulation is adequate, we're really protecting
5 against real-life accidents and go back and look at
6 real-life accidents. And if you study real-life
7 accidents, you would find that nothing bad happens
8 because you have a cask designed to a standard. I
9 think that's sort of where you want to be.

10 CHAIRMAN RYAN: Well, I think that's one
11 of the strengths of your study is you really have a
12 pretty robust database of miles of accidents. You
13 know, you've got a mile of gasoline. You go back
14 years and years. There's nothing left out.

15 So that's a strength, and I think that is
16 something to emphasize in your report. If you're not
17 making up an accident scenario, you have developed
18 that accident scenario from actual experience over
19 many, many gazillions of miles. So that's a plus.

20 The one area I think -- it's just a
21 question more than anything. I remember a few years
22 ago we talked. And Milt Levinson asked about DOD and
23 DOE experience on miles with these kinds of shipments.
24 Is that in your database?

25 I know you're looking at what's in

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1 commerce. And this, of course, wouldn't be in
2 commerce, but as a fraction of the total, DOD and DOE
3 have put a lot of stuff on the rail.

4 MR. EASTON: Well, I will double-check
5 that, but I believe it is because naval reactor
6 shipments for most DOE do use commercial carriers.

7 CHAIRMAN RYAN: And I think if you could
8 just qualify and say that is included or that's not
9 included or part of it is and part of it's not, that
10 would be an enhancement to the power of your scenario
11 development.

12 You know, it's not just commercial nuclear
13 power fuel that's going from A to B. It includes the
14 broad spectrum of radioactive material shipments in
15 this arena. And if you just qualify that a little
16 bit, I think it would be a real -- you know, would
17 bolster your case.

18 MR. EASTON: I don't remember if DOE has
19 any secret trains that they know, but they're probably
20 not in the database.

21 CHAIRMAN RYAN: Yes.

22 MR. EASTON: I know Navy reactors, they go
23 out and hire Union Pacific. And that's all answered.

24 MEMBER WEINER: Staff, questions?

25 MR. WIDMAYER: Well, I have one.

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1 It's Derek Widmayer, ACNW staff. I'm not
2 advocating --

3 CHAIRMAN RYAN: Could you come up to the
4 table, please?

5 MR. WIDMAYER: Should I kneel?

6 (Laughter.)

7 CHAIRMAN RYAN: You can if you want.

8 MR. WIDMAYER: I'm not advocating this as
9 part of the study but just a curiosity. As Dr. Ryan
10 said, it seems like you have a tremendous amount of
11 data on accidents and you have covered your bases.
12 Did anybody ask you to extend that, think out of a
13 box, and think about if somebody attacked the train
14 and did this on purpose and --

15 MR. EASTON: Well, we have another whole
16 independent effort that looks at somebody attacking
17 casks or security systems. I guess --

18 CHAIRMAN RYAN: That's a separate area we
19 probably should just leave right there.

20 MR. CAMPBELL: This is Larry Campbell.

21 That's really outside the scope of this
22 study. And now you're into safeguard space and
23 classified space. So that's outside the scope of
24 this.

25 CHAIRMAN RYAN: Thanks for your question,

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1 Derek.

2 MR. WIDMAYER: Okay.

3 MEMBER WEINER: Other questions?

4 (No response.)

5 MEMBER WEINER: Nobody? Well, thanks very
6 much.

7 CHAIRMAN RYAN: This is great follow-up.
8 It really is good, and I'm pleased to hear that some
9 of the comments you have received from the public have
10 --

11 MR. EASTON: We'll have to come back on
12 this one.

13 (Laughter.)

14 CHAIRMAN RYAN: Thank you very much.

15 With that, we're a little bit ahead.
16 We'll go ahead and take a break and resume at 10:30.
17 By the way, this will conclude our formal part of the
18 record. We're going to be considering letter writing
19 and other activities. So the record will close here.
20 Thank you.

21 (Whereupon, the foregoing matter was
22 concluded at 9:59 a.m.)

23

24

25