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1 UNITED STATES OF AMERICA

2 NUCLEAR REGULATORY COMMISSION

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4 ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

5 (ACRS)

6 + + + + +

7 RADIATION PROTECTION & NUCLEAR MATERIALS

8 SUBCOMMITTEE

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10 TUESDAY, JUNE 5, 2012

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12 ROCKVILLE, MARYLAND

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14 The Subcommittee met at the Nuclear
15 Regulatory Commission, Two White Flint North, Room
16 T2B1, 11545 Rockville Pike, at 1:00 p.m., MICHAEL T.
17 RYAN, Chairman, presiding.

18 COMMITTEE MEMBERS:

19 MICHAEL T. RYAN, Chairman

20 J. SAM ARMIJO, Member

21 DENNIS C. BLEY, Member

22 HAROLD B. RAY, Member

23 STEPHEN P. SCHULTZ, Member

24 JOHN D. SIEBER, Member

25 GORDON R. SKILLMAN, Member

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WASHINGTON, D.C. 20005-3701

1 NRC STAFF PRESENT:

2 CHRISTOPHER BROWN, Designated Federal Official

3 TAE AHN

4 KEITH COMPTON

5 DARRELL DUNN

6 BOB EINZIGER

7 MIRELA GAVRILAS

8 CHRIS JACOBS

9 BANAD JAGANNATH

10 YONG KIM

11 TIM MCCARTIN

12 ABY MOHSENI

13 JAMES RUBENSTONE

14 DOUG WEAVER

15 ALSO PRESENT:

16 JOHN KESSLER, EPRI

17 ROD MCCULLUM, NEI

18 MARC NICHOL, NEI

19 JEFF WILLIAMS, DOE

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		3
1	T-A-B-L-E O-F C-O-N-T-E-N-T-S	
2	Opening Remarks and Objectives,	
3	by Dr. Michael Ryan, ACRS	4
4	Staff Opening Remarks	
5	by Dr. James Rubenstone, NMSS	5
6	NRC Draft EST TIN Report	
7	by Dr. James Rubenstone, NMSS	7
8	DOE Efforts on EST	
9	by Mr. Jeff Williams, DOE	87
10	Extended Storage Collaboration Program	
11	by Dr. John Kessler, EPRI	103
12	Industry Perspective and Efforts	
13	by Mr. Rod McCullum, NEI	139
14	NRC Staff Closing Remarks	
15	by Dr. James Rubenstone, NMSS	177
16	Committee Discussion	
17	Dr. Michael Ryan, ARCS	179
18		
19		
20		
21		
22		
23		
24		
25		

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

(1:00 p.m.)

CHAIRMAN RYAN: The meeting will now come to order. This is a meeting of the Advisory Committee on Reactor Safeguards, Subcommittee on Radiation Protection and Nuclear Materials. I'm Michael Ryan, Chairman of the Subcommittee.

Committee members in attendance are Sam Armijo, Harold Ray, Dennis Bley, Dick Skillman and Jack Sieber. Oh, I'm sorry and Steve Schultz. The Subcommittee will hear presentations by and hold discussions with representatives of the NRC Staff, EPRI, NEI and DOE on extended storage and transportation, technical information and information needs.

The subcommittee will gather information, analyze relevant issues and facts and formulate proposed positions and actions as appropriate for deliberation by the full committee. Christopher Brown is the designated federal official for this meeting.

The rules for participation in today's meeting have been announced in the Federal Register as part of the notice of this meeting, previously published in the Federal Register on May 24th, 2012.

A transcript of the meeting is being kept

1 and will be made available as stated in the Federal
2 Register notice. It is requested that speakers first
3 identify themselves and speak with sufficient clarity
4 and volume so they can be readily heard. We ask at
5 this time that you silence your phones or other
6 electronic devices. Also understand that staff from
7 the center will be listening in on the briefing.

8 This is the second subcommittee briefing
9 on Extended Storage and Transportation. The first one
10 was on September 22nd, 2011, in which the staff
11 discussed a four-phase approach for regulating
12 extended fuel storage. Also brought up fuel cladding
13 integrity and other type performance were also
14 discussed.

15 The ACRS full committee briefing is
16 scheduled for July 11th, 2012. We will now proceed
17 with the meeting and I call on Jim Rubenstone, Branch
18 Chief at NMSS to begin. Jim, welcome and thank you
19 for being here.

20 DR. RUBENSTONE: Thank you, Mike, for
21 having us here. We're glad to have the opportunity to
22 talk about a recent report that the staff has put out
23 for public comment, and I think the Committee has seen
24 that.

25 CHAIRMAN RYAN: Yes.

1 DR. RUBENSTONE: And we'll get into that.
2 Just before I get into the slides I wanted to make
3 sure I introduced some of the players on our team who
4 are here. To my right, Bob Einziger who I think most
5 of you know is our technical lead for this project at
6 NMSS.

7 And Darrell Dunn, from the Office of
8 Research as the technical lead there. A lot of the
9 work is being coordinated between NMSS and Office of
10 Research. And this report I'll be speaking about is
11 a joint product of those offices.

12 Also Chris Jacobs is the project manager
13 for this effort. Keith Compton next to him, is
14 another one of our technical staff. And Tae Ahn I
15 think many of you know is another technical staff
16 who's contributed and we have others in the audience
17 who are supporting us at different levels. So that's
18 the team.

19 What we're here to talk about today is
20 primarily this report, as I said, that came out for
21 comment in the beginning of May. A 45-day comment
22 hearing closes in about two weeks, the 18th. And so
23 far we don't have many comments in but we are
24 expecting to get some. Especially from industry and
25 some other parties who are interested in the technical

1 aspects of this work.

2 I'll walk through the slides here, give
3 you a little bit of context, but not too much, just to
4 remind people what we're doing on extended storage and
5 then go through how we developed our technical
6 information needs. What we used as criteria to rank
7 things. What the ones that rose to the top were. And
8 a little bit about some of the other areas that we'll
9 be pursuing following this up. So if there are no
10 questions at this point I can jump right into the
11 slides.

12 So as I said, I'm Jim Rubenstone, I'm a
13 Branch Chief in NMSS and I'm here on behalf of our
14 larger group who has been working on this issue now
15 for some months. Just to give you an overview of what
16 we'll be speaking about today, we are operating in
17 what could be described generously as a changing
18 policy environment. It's not settled by any stretch
19 of the imagination. There are some things that are
20 coming together.

21 We're trying to position ourselves to be
22 ready for however it moves and continue doing NRC's
23 job. I'll talk a little bit about the existing
24 framework that we're building on as we look at a
25 possibility of extended storage over multiple decades,

1 or longer. And then the technical information needs,
2 as I said, is the centerpiece of this discussion. And
3 then the next steps going forward.

4 This is probably not news to anyone here.
5 We're in transition, but extended storage and
6 particularly dry storage, looks like it's going to be
7 a component of wherever the policy leads us.
8 Alternative disposal options, disposal is still the
9 end of the fuel cycle. Disposal in a geologic medium.

10 We have had direction from the Commission
11 to work on this area on extended storage and
12 transportation and preparation. And I'm sure also
13 most of you are familiar with the recommendations of
14 the Blue Ribbon Commission, which came out in January
15 of this year. And at the end I will highlight a
16 couple of those recommendations that have some
17 implications for storage and transportation and where
18 they may lead us.

19 So again, just very briefly, I want to
20 remind people what these things look like. Currently
21 there's about 18,000 metric tons of commercial spent
22 fuel in dry storage, that's in about 1,500 casks.
23 There's a number of storage designs that are out
24 there.

25 The simplest ways to group the systems are

1 what we call canistered systems and integrated
2 systems. The canistered systems have an internal
3 welded canister which is then placed in an overpack.
4 What I call the integrated are the ones with the
5 interior metal canister and the concrete are one, and
6 those are usually bolted shut. And then the most
7 obvious is some of them stand up and some of them lay
8 down.

9 Current regulations for storage are
10 captured in 10 CFR Part 72. There are --

11 MEMBER ARMIJO: James?

12 DR. RUBENSTONE: Yes?

13 MEMBER ARMIJO: Just go back. Is there
14 any preference from the staff related to whether it's
15 horizontally stored or vertically stored as far as any
16 kind of loading that would be --

17 DR. RUBENSTONE: I don't think there's any
18 favorable.

19 MEMBER ARMIJO: -- favorable or
20 unfavorable?

21 DR. RUBENSTONE: I think you have to
22 analyze them for the conditions they are. And we'll
23 get into a little bit about the types of analysis that
24 are done for storage and you can see how it may make,
25 you know, one orientation may make a difference. The

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1 difference between the canisters and the bolted
2 systems, the welded and the bolted, do make a
3 difference. The U.S. is increasingly in a canister
4 welded mode. There are bolted systems out there. I
5 think they're not as, I don't know what the --

6 MR. DUNN: I think about 89 percent of
7 them are welded.

8 MR. EINZIGER: We don't tell the applicant
9 whether they have to be vertical or horizontal or
10 whether they're welded or bolted. That's up to the
11 applicant what they want to get licensed and the
12 utilities what they want to use.

13 MEMBER ARMIJO: I'm probably jumping ahead
14 to the issue of long-term degradation under, you know,
15 precipitation of hydrides and things like that and
16 whether if you have horizontal loading you'll have
17 appending loads, even though they may be very, very
18 small, that would accentuate any problems compared to
19 just axial.

20 DR. RUBENSTONE: I think maybe one answer
21 is we're looking at that. And the other is that some
22 of the uncertainties right now is I think those
23 differences are within the uncertainties of some of
24 the other material properties.

25 MEMBER ARMIJO: Yes, okay.

1 DR. RUBENSTONE: But we may learn more as
2 we progress. So yes, fair question. 10 CFR Part 72,
3 this covers storage, both dry and wet storage at
4 reactor sites and potentially at non-reactor sites.
5 The two key factors are there are certificates of
6 compliance that are issued for the system.

7 And then there are licenses for the
8 independent spent fuel storage installations, the
9 ISFSIs. Both of these are issued for terms. The
10 initial terms were 20 years, NRC has recently amended
11 the rules to allow up to 40 year initial terms. And
12 their extension, the renewal periods, again, initially
13 were 20 and now can be up to 40 years. There's not
14 requirement that they be issued at 40 year increments.
15 And part of the renewal, the license renewals aging
16 management plans are an important component of that.

17 Historically dry storage was put into
18 place in the U.S. in the late 1980s, so many of the
19 original 20 year certificates and licenses have come
20 up and there's a wave of them coming through for
21 renewal now. So we're involved under, our current
22 licensing activities, in a fair number of certificate
23 and license renewals.

24 For extended storage we are looking at
25 periods beyond that and we don't have a hard and fast

1 definition of what constitutes extended storage, but
2 operationally we've been thinking of it as the second
3 renewal of these systems. And as you can imagine the
4 aging management plan that one would present at the
5 second renewal should probably be different than the
6 one presented at the first.

7 Transportation is under 10 CFR Part 71,
8 which covers all sorts of transportation containers
9 with some specific requirements for the transportation
10 of spent nuclear fuel. That's also term
11 certifications with renewals.

12 And one current feature is the
13 transportation certificates are generally done
14 separately from the storage certificates, although
15 there are a number of systems out there that are dual
16 certified for both transportation and storage with
17 different configurations of the overpack.

18 There are also a number that have been
19 designed for both storage and transportation but don't
20 yet have a transportation certificate.

21 MEMBER BLEY: Jim, let me ask you a couple
22 of questions about who does what if you will.

23 DR. RUBENSTONE: Sure.

24 MEMBER BLEY: In general, and I guess it's
25 by agreements. I think it's by agreements. NRC, as

1 far as transportation, only licenses the casks and I
2 guess DOT and DOE regulate everything else?

3 DR. RUBENSTONE: The Department of
4 Transportation for commercial materials has a role in
5 all shipments. And maybe Bob can give --

6 MR. EINZIGER: For commercial shipments,
7 you're right, the NRC license essentially the cask and
8 in. The DOT licenses the rest of it. Now there are
9 certain materials that can be transported and stored
10 under DOE 8 eGIS, and they have the control over those
11 items.

12 MEMBER BLEY: Okay. Back to your first
13 one, the general topic here on long-term storage. We
14 got a copy of a NWTRB Report that raised a few issues,
15 but first an organizational question. What's the
16 relationship between that board and NRC and issues
17 such as this?

18 DR. RUBENSTONE: Well, NWTRB is an
19 advisory board to the Department of Energy. And they
20 were first setup I think as part of the Nuclear Waste
21 Policy Act.

22 MEMBER BLEY: Yes, that's what I thought.

23 DR. RUBENSTONE: So we are certainly aware
24 of all their activities. We've presented at their
25 meetings, we've attending their meetings, we've

1 discussed things with the staff, but their advise goes
2 to DOE.

3 MEMBER BLEY: Okay. But from the Report
4 one of the issues raised was the lack of experience
5 with extended storage and the need for either further
6 research or continuing monitoring over time as we
7 gather the experience. What's our technical basis for
8 extended storage and with those issues what are we
9 doing with respect to it?

10 DR. RUBENSTONE: Well that's part of the
11 main subject of this report, it's to identify what
12 research needs to be done to put it on a firm basis.
13 Now, one also has to realize the roles of the various
14 participants in this.

15 The NRC's role, and Jim is going to get
16 into this later, is to determine certain needs with
17 respect to regulation. What we need to know in order
18 to regulate. That doesn't mean developing a full
19 database. The database necessary to put in an
20 adequate license for extended storage or for
21 transportation is the role of DOE and the industry.

22 They have to make a case that they can
23 meet all the requirements of Part 72 and Part 71 in
24 order to meet those requirements. Our job is to make
25 sure we're in a position to ask them the right

1 questions. To evaluate the data that they give us and
2 to make sure that they're meeting the requirements.

3 MEMBER BLEY: And the last one, kind of
4 along these general lines, is the Blue Ribbon Panel
5 gave recommendations, I guess to the president, right?
6 Since the president set it up?

7 DR. RUBENSTONE: To DOE.

8 MEMBER BLEY: To DOE?

9 DR. RUBENSTONE: Yes.

10 MEMBER BLEY: So you're going to talk
11 about those later, but they don't have any actual
12 force I assume. But they're -- I'm not assuming, I'm
13 wondering.

14 DR. RUBENSTONE: Well, we will have
15 someone from DOE here in the second half of the
16 meeting. And I can give you my opinion but his might
17 count more on that.

18 MEMBER BLEY: Okay. Well I mean with
19 respect with what NRC does, is what I meant.

20 DR. RUBENSTONE: Yes, but I think what NRC
21 is doing is using those recommendations as a way to
22 evaluate where the policy may go so we're positioned
23 properly. We certainly aren't making the decisions as
24 to what the nation's policy for waste management
25 should be.

1 MR. EINZIGER: A for instance on that is
2 that normally now storage, we follow storage with
3 transportation to some site. If the Blue Ribbon
4 Panel's recommendation is put in place and they have
5 interim site then we have to consider what the
6 ramifications are of storage followed by
7 transportation then by storage again. Or just
8 transportation followed by storage. And so we're
9 cognizant of the fact that we've got to look into
10 these considerations.

11 MEMBER BLEY: Okay. So if you think of
12 long-term storage, our thinking has to include the
13 idea that there might be movement partway during this
14 lifetime.

15 DR. RUBENSTONE: Right. And we'll get to
16 that when we talk about, two things. One, the BRC
17 recommendations specifically. And then just generally
18 how we are analyzing the technical requirements, which
19 is keeping this transportation component in mind,
20 because the analysis that are done to satisfy 71 are
21 very similar, but not the same as the ones you do in
22 72. There's different things you look at. And we can
23 talk about that a little bit further as we get into
24 more of the technical piece.

25 MEMBER BLEY: Thank you.

1 MEMBER SKILLMAN: What is the process of
2 extending, life extension if you will, on a term or a
3 certificate? What is the process for that, please?

4 DR. RUBENSTONE: I think Bob can talk
5 about the process.

6 MR. EINZIGER: The applicant comes in with
7 a Safety Analysis Report. We evaluate them. We grant
8 them a license if everything is correct for an initial
9 period of time. Before that's expired they have to
10 tell us that they're going to come in for a renewal.
11 They have to write an SAR essentially telling us that
12 they meet all the requirements for meeting Part 72.
13 We evaluate that. We determine whether we feel that
14 the data supports a extension. And if so there's an
15 SAR written by the staff and an amendment to the
16 certificate.

17 MR. EINZIGER: Thank you.

18 MEMBER SCHULTZ: Is there guidance
19 specifically associated with the extension? Or is the
20 guidance associated with the initial safety analysis
21 report?

22 MR. EINZIGER: The first two extensions
23 that were done were prior to when any guidance was in
24 place. Then there was a standard review plan for
25 license extension that was drafted. Remembering that

1 this is guidance to the staff, and what the staff
2 should look for when they're reviewing an application.
3 That is a public document though, so the applicants
4 can see what the staff is going to look for. And to
5 some extent the staff, the licensee, follows that
6 guidance.

7 We're in the first application now where
8 that guidance is actually being tested. Because it's
9 the first one, as with most things when they first get
10 dry runned, we are finding some things that need to be
11 changed and corrected.

12 It's important to remember though, that it
13 is guidance for the staff. It's not a checklist to
14 the applicant that says if you do X, Y and Z you're
15 granted a license. The applicant's responsibility is
16 still to meet all the requirements of Part 72.

17 MEMBER SCHULTZ: Understood. Thanks, Bob.

18 DR. RUBENSTONE: I think that's NUREG
19 1927.

20 MR. EINZIGER: 1927 I think.

21 MEMBER SIEBER: I think I'll just wait a
22 little bit to ask my question.

23 DR. RUBENSTONE: Okay, that's fine.

24 MEMBER SIEBER: Because sooner or later
25 you have to touch on it anyway.

1 DR. RUBENSTONE: Well let's hope so.

2 MEMBER BLEY: You know it'll come up,
3 right.

4 DR. RUBENSTONE: One of the reasons this
5 is in here is because our working model going forward
6 is that for extended storage the current framework is
7 the basis. And it may need some small adjustments but
8 we're not seeing, at this point, the need for
9 wholesale changes in the current regulations for
10 storage and transportation to address this extended
11 period.

12 So one of the challenges of -- Sorry,
13 Mike, the challenge of what we're trying to do and the
14 motivation for what we're trying to do is can we
15 identify anything that would lead us to change those
16 regulations or guidance. We almost certainly will be
17 issuing new guidance as we go into extended storage,
18 but the regulatory framework we're starting with the
19 assumption that we have what we need in place and will
20 just be adjusting it if necessary.

21 CHAIRMAN RYAN: I was going to ask you as
22 you go through your presentation if you could maybe
23 point to those things that you think would be the
24 areas where there would be some of these smaller
25 changes are. And just give us a flavor for what those

1 things are versus say wholesale changes. That would
2 be very helpful.

3 DR. RUBENSTONE: I think the aging
4 management is one key, because there's not a lot in
5 the regulation about it and there may not need to be,
6 but the guidance is going to really help get --

7 MEMBER ARMIJO: Do you think the
8 regulation is worded broadly enough that aging should
9 be taken into account, independent whether it's the
10 initial application or follow on?

11 DR. RUBENSTONE: Right. I mean I give
12 credit to the people who wrote the regulations in the
13 first place because they left sufficient flexibility
14 without being so vague, which as we know is the path
15 we try to walk in writing regulatory language. So
16 it's just a matter of whether we need to tune that at
17 all. And as I said so far we haven't come up with
18 specific ones but there's some areas that we might
19 need to look at.

20 MEMBER ARMIJO: But as far as physical
21 phenomenon, new phenomenon, new mechanisms of
22 degradation of the canisters or the casks or the fuel
23 planning itself, those things have already been
24 addressed in the initial guidance?

25 DR. RUBENSTONE: No, not really. I mean

1 we've addressed in the initial evaluation those things
2 that we think are going to occur during the first
3 period of storage. And for the fuels that we think
4 are going to be stored. The purpose of this document
5 is to look beyond that and say, okay now we're going
6 into an extended period of time.

7 Are there other mechanisms that are going
8 to occur? What might they be? Are there things
9 happening during the first storage period that might
10 not really be detrimental during that storage period
11 but might show up as an effect later on. So this is
12 extending the thinking.

13 MEMBER ARMIJO: So extending it to
14 actually include new degradation mechanisms, other
15 than what was originally --

16 DR. RUBENSTONE: I don't think the
17 regulations called out specific mechanisms, it's a
18 performance based regulation. So it talked about the
19 type of design criteria. And I'll get into that a
20 little bit.

21 MEMBER ARMIJO: Okay.

22 DR. RUBENSTONE: And what sorts of safety
23 functions different components will perform. And then
24 the burden becomes on the applicant to demonstrate
25 that they have considered these going forward and that

1 those functions will be met. So that, to me that's
2 what makes this a good platform to build off for
3 extended storage as there isn't some prescriptive list
4 of only look at these things. It's this is the
5 performance you need, so if we recognize a phenomenon
6 that --

7 MEMBER ARMIJO: These are the properties
8 you want at any time during the life of this --

9 DR. RUBENSTONE: Right. So we need to
10 accomplish this purpose and if some phenomenon crops
11 up many years out, that doesn't crop up early, you
12 need to address that when you're at that appropriate
13 stage.

14 MEMBER ARMIJO: Right, okay. Thanks.

15 MEMBER SIEBER: I think I will ask my
16 question. And it's not so much of a question, but my
17 initial assessment based on what I've read, the
18 contemplated design lives, I think that is envisioned
19 that you obviously would not license to, but the
20 vision for a designer is 300 years, is that correct?

21 DR. RUBENSTONE: No that's not. We don't
22 have any contemplated life time. We grant an initial
23 license now of up to 40 years and then we will grant
24 as many licenses as the applicant can make the case
25 that they meet the regulation. We're not intending to

1 issue 300 year licenses or 100, only be --

2 MEMBER SIEBER: I understand that. That
3 was part of my question. That's not your intention?

4 DR. RUBENSTONE: No.

5 MEMBER SIEBER: That the vision, the
6 design life could be as much as 300 years.

7 DR. RUBENSTONE: I think the vision for
8 the systems that things may need to remain in storage
9 for 300 years is different than saying you're
10 designing a particular --

11 MEMBER SIEBER: No.

12 MR. EINZIGER: The 300 year --

13 DR. RUBENSTONE: Containers will last for
14 300 years.

15 MR. EINZIGER: -- came up because we
16 didn't want to analyze for 1,000 or 10,000 or a
17 million years. We wanted to have some finite period
18 of time. There is no, as of yet, there is no
19 technical justification for that period. It may be
20 during the course of our investigation, or DOE's or
21 EPRI's investigation, that some phenomenon comes up
22 that says you can't go that long. But as of yet we
23 haven't identified it.

24 MEMBER SIEBER: Well that leads to my next
25 question. You have something like 1,800 canisters

1 sitting out there now, right? And there is no real
2 way, particularly in the short-term, to determine
3 every effect that is occurring that is a grading
4 effect or the extent to which these intermingle and
5 reinforce themselves.

6 And short of taking a few of these casks
7 apart and looking at the fuel and looking at the
8 condition of the cask, it's not clear to me that we
9 can identify every possible degradation mechanism that
10 will occur during an extended period of time.

11 And it's also not obvious to me how you
12 would find out if that's going on short of some huge
13 research project for disassembling casks to actually
14 physically measure them. And I'm having difficulty
15 reaching out into the future to try to figure out how
16 it is you're going to do that. And it seems to me
17 like what you're planning is let the licensees figure
18 it out and convince us that they're okay.

19 MR. EINZIGER: No, not quite. I tend to
20 agree with everything you've said except for the huge
21 research project. We make our judgements based on
22 what we call separate effects testing. We test for
23 various mechanisms and how they are in there and then
24 we make a guess of what we think is a reasonable
25 lifetime. Now, one of the parts of this program, and

1 I don't know whether we're going to touch on it, is
2 what is called a demonstration program.

3 DR. RUBENSTONE: I think that will come up
4 probably in the second half of the meeting, because
5 John was going to do that.

6 MR. EINZIGER: And basically that
7 demonstration program is to stay ahead of the curve.
8 To see if what we think is happening is really what's
9 happening. And also it recognizes the fact that there
10 might be something out there that we might have missed
11 and it could turn up during this monitor
12 demonstration.

13 MEMBER SIEBER: Okay. I'll wait and let
14 you go through that, but right now I'm not convinced.

15 DR. RUBENSTONE: No, that's fine. I
16 think, I'm not going to get into the demo, what's been
17 talked about. I think John will pick that up. But
18 just to make sure we understand that we're not saying
19 that over the next few years we will solve the 300-
20 year storage problem and then we'll just forget about
21 it until 300 years are up. The idea is we will look
22 at what we have identified now. Try to get our best
23 estimates on when these phenomenon become important,
24 and some of them may never become important.

25 And that's one of the challenges we're

1 trying to wrestle with. But this is part of an active
2 NRC licensing, oversight, inspection, the whole
3 package of regulation. So if you look at it from can
4 I make this safe now for 300 years that's a different
5 question than what do I need to do now.

6 MEMBER SIEBER: No, I didn't ask that
7 question.

8 DR. RUBENSTONE: Right, so I just wanted
9 to make sure we're on the right line on that. So we
10 picked up some of this already. Our most number one
11 need is to look at what potential changes to
12 regulations and guidance might be needed to
13 accommodate long-term storage, and transportation then
14 of fuel that has been stored for some longer periods.

15 And we're starting out by looking at the
16 technical issues, which I think most people from
17 engineering point of views would say is the place to
18 begin. Those will then form any potential regulatory
19 changes. Now there are potential regulatory changes
20 that aren't directly derived from technical issues and
21 we'll talk about those a bit later on.

22 But once we identify what these issues are
23 and we've taken our first attempt at this and report
24 this out for comment now, then we can move into
25 performing the focused research on those areas. In

1 order, as Bob said, to determine what NRC needs to
2 know. And what NRC needs to know, reinforcing what
3 Bob said, is not exactly the same thing as what we
4 expect the licensees to

5 We need to know, first off, is this an
6 issue that we should be worried about? And if it is
7 what sorts of information will we need to know in
8 order to evaluate an application coming in. So in my
9 mind the dual purpose of this report is both to help
10 define NRC's research program going forward but also
11 to inform the industry of what NRC sees are the
12 information needs going forward.

13 We do not have either the staff, the
14 resources, the time to do the full-blown program that
15 one would need to resolved every potential question.
16 So we are focusing our efforts on those areas that,
17 one, we think have the biggest impact in regulatory
18 space. And two, it will accomplish what I said NRC
19 needs to know.

20 And I think there's been good response so
21 far from the industry, and you'll hear that in the
22 second half today, that they're recognizing very much
23 the same issues in their own work and beginning their
24 work on those issues, including things that would give
25 one the bigger picture rather than just focusing on

1 individual tests. So hopefully we'll capture all of
2 that as we go forward in this section.

3 MEMBER SKILLMAN: Jim, please let me ask
4 a brief question. When we began the campaign to ship
5 the waste from TMI 2, we had some ready-to-go casks
6 that various vendors had but had to build a couple
7 custom casks. And as we went through the process we
8 found ourselves dealing with 10 CFR 20 for shielding.
9 10 CFR 50 Parts 71 and 72.

10 We also found ourselves connected to 49
11 CFR, the transportation regulations. And that was a
12 surprise for us because most of us were fairly
13 comfortable over in Part 10, but none of us had ever
14 spend any time in Part 49.

15 So as you talk about transportation my
16 question is, have you ventured over into the DOT
17 transportation regulations to understand how they can
18 impact the decisions that you make be making under
19 Title 10?

20 MR. EINZIGER: Not really. But we are
21 aware of some of the regulations. We have people who
22 have worked over in DOT that inform us of some of
23 those regulations. But in terms of the influence it
24 might have on the cask itself we have not looked at
25 that.

1 And I can see where there's an
2 interaction. If the DOT had a regulation on what the
3 maximum vibration spectra a truck could see. Or a
4 road they could go over that would effect what kind of
5 impact limiters we might have on a transportation cask
6 or what shock the fuel might see during normal
7 transportation. But we haven't spent a lot of time in
8 that, no.

9 DR. RUBENSTONE: Yes, I don't think we've
10 been explicitly working in that. But as Bob said,
11 because we have experience in licensing transportation
12 packages those reviewers are aware of some of those
13 constraints. Now, the U.S. has not engaged in a
14 large-scale spent nuclear fuel shipping campaign.
15 There have been shipment of spent nuclear fuel, but
16 not on a large scale. The U.S. was gearing up for
17 that at one point, which is now on hold.

18 So there was some preliminary work. And
19 that involved coordination between NRC staff, DOT,
20 DOE, which would have had a role in that campaign. So
21 there has been some groundwork done. We have some
22 awareness. But we haven't, as Bob said, gone to the
23 explicit rule-by-rule thing. So that's a good thing
24 to look at going forward as we look at the
25 transportation.

1 MEMBER SKILLMAN: I just wonder if it may
2 have an impact on your conclusions?

3 DR. RUBENSTONE: Yes, I think it might.
4 Most of our transportation conclusions we have, and
5 we'll get to this as we get into more details, we
6 didn't come up with specific degradation mechanisms
7 that we only worry about in the transportations phase.
8 They may become more significant in the kinds of
9 analysis one has to do there as opposed to storage.
10 But I think we could expand our circle a little bit
11 and look into if there's anything specifically in the
12 DOT Regulations that may impact this.

13 MEMBER SKILLMAN: Thank you.

14 DR. RUBENSTONE: So this is the report
15 and, like I said, I think you've all seen if not a
16 hard copy and electronic copy of it. It's out for
17 public comment now. As our first cut we focused just
18 on the dry storage systems because we see that as the
19 major way of storing fuel for extended periods. And
20 we looked at what degradation phenomena can do to the
21 system, structures and components and their
22 performance.

23 We were considering the impact on the
24 safety functions as defined within the regulations
25 and, again as we've said, what level of understanding

1 does NRC staff need in order to do its regulatory
2 review. So we built on some previous work that had
3 been done, including a study that we sponsored at
4 Savannah River National Lab to update some earlier
5 work they had done to look at potential degradation
6 over extended periods.

7 We looked at a report that had come out
8 from the Department of Energy from the Nuclear Waste
9 Technical Review Board. I think this one you referred
10 to earlier. And the Electric Power Research Institute
11 also put out their Gap Assessment of technical needs.
12 And this was where Darrell's team and research stepped
13 in for the report. That analysis is contained in the
14 first appendix of this report where we go through and
15 look at what is the level of knowledge for each of
16 these degradation process as we know.

17 And we're really looking at three specific
18 instances. When will this degradation begin and under
19 what conditions? How fast does it progress once it
20 begins? And then, what is the end state? Is the end
21 state complete failure of the component? Or is it a
22 rest before you get to complete failure?

23 And then laid on top of that is also
24 questions about the level of knowledge about how could
25 one monitor this, how could one inspect for these

1 things as they're moving along. And what mitigation
2 might be available to stop some of these things in
3 process if you pick them up.

4 So we were try to do a, sort of as broad
5 a sweep as we could of all the phenomena that were
6 recognized by these other reports that we had come up
7 with, answer these questions. And then once we had
8 that level of knowledge report we overlaid on top of
9 that, okay, for these phenomenon, if they progress,
10 how would they impact our review.

11 How do they match up with the regulatory
12 requirements that are looked at when staff has an
13 application or a renewal application for a certificate
14 or for an ISFSI. So we really took the two approaches
15 and overlaid them and then see what issues came up to
16 the top.

17 For the regulatory criteria there are five
18 basic design criteria that are included in Part 72
19 that map precisely to safety functions for the systems
20 to perform. Confinement, control of criticality,
21 shielding from regulation, structural integrity and
22 thermal control, the ability to remove heat from the
23 system.

24 And additional considerations from the
25 regulatory point of view is the ability to retrieve

1 the fuel from storage, by normal means. And then the
2 impacts on the transportation. If these phenomenon
3 happen they may be fine while it's in storage, you put
4 it in transportation you're subjecting it to different
5 conditions, different sorts of analysis. How might
6 that affect your review at that stage?

7 So perhaps not surprisingly, the ones that
8 came as high priority technical information needs had
9 an overall low level of knowledge about one of these
10 phenomenon. We went through a number of them where we
11 felt very comfortable with what was known about them.
12 And an overall high impact on one or more of the
13 regulatory criteria. And those became our highly
14 ranked ones, which are summarized in the report here.

15 We have tables that go through some of the
16 lower ranked ones. That's not saying that those are
17 completely irrelevant, but we wanted to focus our
18 attention on the things that had the highest impact on
19 the regulation, on the review and the overall low
20 level of knowledge where more knowledge could really
21 help us determine if this was in fact an issue.

22 We identified three, what we call
23 crosscutting issues, that affected either multiple
24 components of the system or came into multiple
25 processes, degradation processes, that need to be

1 evaluated. There's several of these processes that if
2 we knew more about one process that would tell us
3 whether some other subsidiary process was important or
4 not and we'll get to one good example of that.

5 And the other thing we detected, and this
6 became clear pretty early on and I think was known to
7 most people who are informed in the field, is that
8 these are not, for the most part, unique to extended
9 storage. They overlap many areas where we have
10 current discussions going on about how to approach it.

11 And particularly that question about when
12 a phenomenon initiates and how fast it progresses,
13 because we discovered that there is uncertainty on a
14 number of things that people said, oh this doesn't
15 start until much later. But when you look at it in
16 detail there may be conditions where it could be
17 happening sooner.

18 And we wanted to clear that up, because
19 we're not just drawing a bright line between extended
20 storage and current storage because the cask doesn't
21 know the difference. And it's seeing things as it
22 evolves and work that we could do in this area could
23 inform everything. And we're trying to keep an active
24 dialogue going with the people who are doing the
25 current reviews and are monitoring the current issues

1 with industry and the work we're doing under extended
2 storage.

3 This is I think, the next two slides are
4 the meat of our discussion where we call out some of
5 the specific degradation areas that we think are
6 important for first priority work. And what I have
7 here are sort of the top three ones we came up with.
8 And then the top three crosscutting issues. And we
9 can spend some time on these if you're interested, or
10 pick them up as we go forward.

11 Stress corrosion cracking of stainless
12 steel canisters. And especially high stress areas
13 like welds on the canisters in a marine atmosphere.
14 Stress corrosion cracking is a relatively well known
15 phenomenon that effects often stainless steel. The
16 questions we're trying to address is is that something
17 that needs to be considered for these particular
18 systems. And when does it become important.

19 And there's two ways to look at this and
20 we're doing work. NRC is sponsoring work on one
21 angle, the industry is coming at it from the other
22 angle. I think they're nicely complimentary. And
23 those are what exactly are the conditions were stress
24 corrosion cracking becomes a problem and then do those
25 conditions exist on canisters, or when will those

1 exist on canisters.

2 And the details of that, what you need for
3 stress corrosion cracking are you need stresses in the
4 material. You need the right material. You need
5 chloride, salts, present and you need moisture
6 present. For relatively hot fuel, relatively early in
7 the storage stage, you may have the stresses, you may
8 have the material that's too hot for water to be
9 there.

10 As fuel cools down over extended periods
11 the outside of the canister could drop into the
12 temperature range where moisture could be present.
13 Especially in an environment where you get salt
14 deposited. Sea salt will deliquesce and pull
15 moisture from the air under certain humidity
16 conditions.

17 We're trying, as I said, we have some lab
18 experiments going now to try to clearly define what
19 those conditions are. And the industry, and I think
20 John will talk to this later on, has an active program
21 going looking at what are the conditions that current
22 casks are experiencing.

23 MEMBER BLEY: What kind of temperatures do
24 you see at the canister early on?

25 DR. RUBENSTONE: Early on it's well over

1 100 C. But if you get fuel with relatively low burn-
2 up, some canisters were loaded relatively light, you
3 can get to lower temperatures over time. The region
4 of deliquescence that you're worried about certainly
5 below 50/40 C, in the presence of salt you can get
6 moisture deliquescing. What that upper temperature
7 limit is, that's something we're looking at now.

8 MR. EINZIGER: You also have to remember
9 that these canisters have a fairly severe temperature
10 gradient on them so that both the upper part of the
11 canister, where the closure weld is, and the lower
12 part of the canister where the bottom is welded on and
13 there's high stresses, will also be lower temperature
14 earlier in the life cycle.

15 MEMBER SIEBER: Now, those temperatures
16 that you just quoted, those are canister temperatures
17 --

18 DR. RUBENSTONE: Right.

19 MEMBER SIEBER: -- as opposed to fuel
20 temperatures which could be in the order of magnitude
21 or more higher?

22 DR. RUBENSTONE: Oh, maybe not an order of
23 magnitude, but considerably high. There's a limit for
24 initial loading of keeping the cladding temperature
25 below 400 C. But that's, and we'll get into this when

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1 I talk about one of the crosscutting issues, that's
2 analyze to find what's the hottest spot within the
3 load. Because you're looking at keeping things below
4 that maximum temperature.

5 MEMBER BLEY: And this is assuming fuels
6 loaded as early as they can be?

7 MR. EINZIGER: No. We have about a five-
8 year limit before most fuel loadings will actually
9 meet the criteria.

10 DR. RUBENSTONE: So these are analysis
11 that are done by the applicant for conditions they
12 want. And we use those analysis for when we grant a
13 certificate that says this is your loading curve limit
14 for what you can put in this canister.

15 MEMBER ARMIJO: I'm puzzled by this
16 particular issue. First of all, as you said, chloride
17 stressed corrosion cracking is a very well-known
18 phenomenon and anybody who used welded stainless
19 steels in a marine environment should know that and
20 should have fabricated their welds in a way to
21 immunize them. If it's shot peening them after
22 welding, periodically washing the cask down in case
23 there's, you know, marine environment. Seems to me
24 that there's a lot of practical ways to deal with this
25 without going into a big research program. A periodic

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1 inspection.

2 MR. EINZIGER: Well, you're right, Sam, in
3 that there's an awful lot of work that's been done on
4 marine stress corrosion cracking. And as my colleague
5 Jeff Hornsetts (phonetic) liked to say, we could fill
6 this whole room with reports on it and most of it
7 wouldn't be applicable to this situation, because the
8 large preponderance of the information is an actual
9 aqueous solutions. There also are ways to do stress
10 relieving of it. And those are being looking into.

11 Right now the NRC doesn't mandate that the
12 way these canisters are manufactured, we just mandate
13 that they behave suitably to meet the safety criteria.
14 So the Japanese are taking a big role in looking at
15 mitigation techniques. In hindsight maybe the vendor
16 should have looked at steps to prevent this problem
17 before it occurred.

18 MEMBER ARMIJO: Would the staff consider
19 periodic inspection and washing down --

20 MR. EINZIGER: Yes --

21 MEMBER ARMIJO: -- as an effective way of
22 dealing with something like that?

23 DR. RUBENSTONE: -- some challenges
24 because of the radiation fields. These things are
25 still relatively hot.

1 MEMBER ARMIJO: I'm not talking of going
2 up there and scrubbing them. I'm talking about
3 getting a water hose and just --

4 MR. EINZIGER: Well let's just talk for a
5 moment about that, Sam. I mean, if the critical
6 density for the salt depositing on the canister takes
7 100 years to occur, or 50 years, maybe washing them
8 down is going to do the job. If the critical density
9 of salt on the canister takes a couple years to occur
10 maybe that isn't a method that will work. In fact
11 I've seen calculations done based on the outliers on
12 the database that says it may only be a few hours
13 before the actual critical density occurs. And then
14 we have a whole new employment method of having people
15 hosing down these things continuously.

16 MEMBER ARMIJO: I think that's sort of
17 Yucca Mountain kind of thinking where these phenomenon
18 are given these super capabilities and without any
19 data.

20 MR. EINZIGER: Yes, that's exactly true
21 and we don't have --

22 MEMBER ARMIJO: Without any data, without
23 any testing.

24 MR. EINZIGER: We don't have the data.

25 MR. DUNN: There actually is data. And

1 there's industry experience with this. There have
2 been reactors that have had problems with chloride
3 stress corrosion cracking from a marine deposition.
4 It happened at St. Lucie, it happened at Turkey Point,
5 it happened at the Koeburg Plant in South Africa.

6 MEMBER ARMIJO: I'm not disagreeing that
7 chloride stress corrosion cracking. What I'm
8 disagreeing with is that you need a big research
9 program as opposed, and this is not a criticism of the
10 staff, it's more of a criticism of the industry of not
11 addressing ways in which to mitigate to prevent this
12 from becoming a big issue.

13 DR. RUBENSTONE: Well I think we all agree
14 there are ways to mitigate it, but those have not been
15 taken so far, the 1,800 casks that are out there have
16 not been stress relieved. And we can discuss whether
17 we could justify putting that in as a condition going
18 forward. What we're trying to get to is, again, the
19 specific conditions so we know when this occurs. And
20 then what the industry is doing is saying, is this
21 occurring, you know, what are the conditions look like
22 out there.

23 And you might have a great appreciation
24 after John's talk about some of the challenges trying
25 to make these measurements. There is some data from

1 Japan, the Japanese are taking this very seriously
2 because all of their sites are marine environments.

3 MEMBER ARMIJO: Hey, their casks were
4 flooded at Fukushima.

5 DR. RUBENSTONE: And they are worried
6 about salt that was deposited during the flooding.

7 MR. EINZIGER: Sam, we're looking at doing
8 the minimum amount of work to determining whether an
9 actual problem exists. We're not looking at doing a
10 big research project. Once we determine that there is
11 an actual problem, either for now or later or very
12 far, then it's up to the industry to do what they need
13 to do to make sure that it doesn't happen during the
14 licensed storage period. They could decide to have a
15 big research project to do it. They could decide to
16 wash them off. They could decide to fabricate them in
17 a different way. But that is, as you mentioned, in
18 the realm of what the industry has to do.

19 MEMBER ARMIJO: Right.

20 MR. EINZIGER: The NRC is trying to
21 minimize the amount of research they need to do to
22 determine whether there's a question we have to ask
23 the industry.

24 MEMBER ARMIJO: One other question. I
25 notice in all these pictures a lot of these things

1 look like they're painted. Are they?

2 MR. EINZIGER: Some are.

3 MEMBER ARMIJO: Like these white ones.

4 Are they anything unique about them to corrosion
5 resistance or anything?

6 MR. EINZIGER: Coatings have been
7 considered.

8 DR. RUBENSTONE: Yes, what you're seeing
9 in most of these pictures is the outer over pack, not
10 the inner --

11 MEMBER ARMIJO: Not the inner container
12 itself? It's not painted over then?

13 DR. RUBENSTONE: Yes, I think in general,
14 and I can't say 100 percent but there hasn't been
15 coatings used on these canister systems that would --

16 MEMBER ARMIJO: There hasn't been any kind
17 of treatment that would minimize --

18 MR. EINZIGER: Only on the ones that are
19 using, as what Jim called, integral systems. And
20 those aren't the austenitic stainless steels.

21 MEMBER ARMIJO: Okay.

22 MEMBER BLEY: I don't remember how long
23 we've been moving fuel into dry storage, what the
24 oldest ones are, but have there been inspections
25 inside the over pack looking at the canisters? Have

1 we seen any problems?

2 MR. EINZIGER: I think that EPRI is going
3 to talk a little bit more about that later on.

4 MEMBER BLEY: Okay, that'll be fine.

5 MR. EINZIGER: So I'll defer that
6 question.

7 MEMBER BLEY: That's fine.

8 DR. RUBENSTONE: The oldest ones are 20
9 plus years. The late 80s were the first deployed
10 commercial dry storage.

11 MEMBER ARMIJO: Do you have any carbon
12 steel casks?

13 MR. DUNN: They're painted ones. In
14 Missouri in 1986.

15 MEMBER ARMIJO: Are they kind of old
16 technology? And then now a modern way you're going
17 all stainless or what?

18 MR. EINZIGER: Well, we're not going any
19 way but --

20 MEMBER ARMIJO: I mean the industry not
21 you. When I say that I mean the people who work in
22 this area.

23 MR. EINZIGER: If you were in Europe most
24 of them are going towards bolted integral dual purpose
25 casks. In the United States most of the industry is

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1 going towards cansiterized systems, welded systems
2 inside and overpack.

3 MEMBER ARMIJO: But mostly stainless steel
4 or carbon steel or an equal amount?

5 MR. EINZIGER: Mostly stainless.

6 MEMBER ARMIJO: Okay.

7 DR. RUBENSTONE: The second issue in this
8 first group is not a big issue, but it maybe is an
9 easily resolved issue. And it's questions about
10 degradation of the bolts. As Darrell said earlier,
11 that's not a big part of the U.S. inventory but it's
12 a question that has regulatory impact. It's probably
13 easily solved, probably through some combination of
14 inspection and monitoring. The bolted system is
15 usually a dual concentric seal and they monitor the
16 pressure between the two seals as a way of looking for
17 seal failure so conceivably both failures would turn
18 up on that monitoring as well.

19 And then the third one is I've rolled up
20 a couple of topics into this one. And it's the
21 effects of the swelling of the fuel pellets over time
22 and pressurization of the rods and how that can drive
23 stresses on the cladding. And this is an example of
24 how we have interrelated phenomenon.

25 On the next slide we talk about some

1 cladding failure mechanisms that mostly depend on this
2 applied stresses from either fracturing the pellets
3 and swelling and pressurization. So if we can resolve
4 the swelling and pressurization question that dictates
5 how we would worry about some of the cladding
6 degradation issues.

7 MEMBER ARMIJO: And you're going to get
8 into the mechanism that drives the fuel swelling?

9 DR. RUBENSTONE: Bob can talk about that
10 right now.

11 MEMBER ARMIJO: Time, temperatures.

12 MR. EINZIGER: Want to talk about that
13 now?

14 DR. RUBENSTONE: Why not.

15 MEMBER ARMIJO: Yes.

16 MR. EINZIGER: Basically we're worried
17 about the decay causing a helium buildup in the pellet
18 and how much of it's staying in the pellet and
19 swelling the pellet. How much of it's being released
20 and increasing the fission gas pressure. When is this
21 going to occur, how it's dependant on the temperature.

22 There's some work out there that seems to
23 indicate that this may not be an effect that's
24 occurring until well past 100 years. But so far it's
25 been calculation. It's been ion implantation work

1 which is forcing the issue. It drives issues such as
2 low temperature creep, delayed hydride cracking. A
3 couple of other mechanisms I'm not yet willing to work
4 on those mechanisms until I really can get some
5 evidence that there's a driving force.

6 MEMBER ARMIJO: But the driver there is
7 helium production?

8 MR. EINZIGER: Yes.

9 MEMBER ARMIJO: And you've got data on how
10 much would be built up?

11 MR. EINZIGER: Yes.

12 MEMBER ARMIJO: Okay, at some point there
13 I want to get into that.

14 DR. RUBENSTONE: Okay. The crosscutting
15 issues, we've touched on the first one which is the
16 thermal model calculations. As we talked about the
17 previous way of approaching this was to calculate what
18 the maximum fuel temperature would be early on and
19 during the loading and early on in the stages because
20 that was seen as an important parameter, and still is,
21 to preserve the cladding lining.

22 But as we look at some of these other
23 issues it's more than just the maximum temperature
24 within the fuel assembly that may make a difference.
25 It may be some minimal temperatures and when you start

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1 reaching lower temperature steps. If you design your
2 thermal models to be conservative to calculate a
3 maximum temperature you probably will not adequately
4 capture what the lower temperatures are over time.

5 And the models also don't look
6 specifically at what the thermal evolution of the
7 outside of the canister is. Only to the extent that
8 there's a sufficient heat transfer to remove heat. So
9 we've suggested that a good area for work is to
10 develop more realistic thermal models that try to look
11 at both the interior and exterior temperatures,
12 because a large number of the phenomena are
13 temperature dependent on both ends.

14 Residual moisture, there's been some
15 interest in this. There are standard drying
16 procedures that the industry follows. There hasn't
17 been a lot of benchmarking work following that to see
18 how effective they are. Some of the residual moisture
19 questions we've done some preliminary work in this
20 area.

21 Our preliminary conclusions is that we're
22 getting down to what we think are the residual amounts
23 of moisture, that everything's fine. There's some
24 reactions that take place but there are no real
25 serious impacts.

1 If we are dramatically off on how much
2 moisture is left in these canisters and if other
3 kinetic processes happen at different rates, these
4 could pose problems down the line.

5 MEMBER ARMIJO: If the quantities are
6 really small they're consumed, by whatever reaction
7 takes place.

8 DR. RUBENSTONE: Well even if the
9 quantities are large they're consumed but then you
10 have different effects.

11 MEMBER ARMIJO: It's how fast it reacts.

12 DR. RUBENSTONE: I mean one thing to
13 remember, and we would appreciate it more when we did
14 a little work is there's a large amount of surface
15 area inside a dry storage canister to react out
16 relatively small amounts of whatever is left. But
17 again, if you have some mechanism by which you could
18 trap more moisture in there than you think, by a large
19 amount, then you could have some issues down the line.

20 MEMBER ARMIJO: How dry is dry? What
21 criteria do you use as far as DPM of water in --

22 DR. RUBENSTONE: The standard drying
23 procedure is basically they empty the water. They
24 force it out, pump on it for 30 minutes and pump on it
25 and --

1 MR. EINZIGER: They pump on it until they
2 get down to three torr, they valve it off and it can't
3 rise in pressure more than three torr during the next
4 30 minutes. Supposedly when you look at the vapor
5 pressure of everything that says you're down to about
6 a quarter of a mole of water in the canister. And our
7 analysis has shown if you're actually down there the
8 mechanisms aren't going to, there's not going to be
9 enough degradation due to that remaining water.

10 Now, are we actually down there? That's
11 the question. Because nothing's ever been benchmarked
12 and you have water that could be sitting below the
13 fuel assemblies so it's rather cool when the drying is
14 taking place. You could have water that's trapped in
15 the crud and in the oxidation level. And we get new
16 information about that, just recently I heard that the
17 radiolysis that they're seeing in the water that's
18 trapped in the oxide could have a g-factor that's 100
19 times higher than they thought, which affects things.

20 So one of the things we're looking at is
21 how dry do we have to get that. And we're in a the
22 process of having an evaluation done now and then
23 doing some benchmarking on the technique.

24 MEMBER ARMIJO: So there isn't any real
25 spec that says after you finished your drying process

1 the water content shall be no great than X ppm or
2 nothing like that?

3 MR. EINZIGER: No.

4 DR. RUBENSTONE: It's the operational
5 procedure with what's the rise in pressure.

6 MEMBER ARMIJO: Okay.

7 DR. RUBENSTONE: And as Bob said for the
8 most part that probably works, but we would like to
9 have some benchmark data if we could.

10 MR. EINZIGER: And that's only guidance to
11 the applicant on where they should be. It doesn't
12 mandate that they have to use that procedure.
13 Fundamentally the licensee gets back to the applicant
14 showing that the five criteria of criticality,
15 containment, et cetera are met.

16 And the last crosscutting area is a very
17 broad one and it's monitoring and inspection methods.
18 Generally inspections have been visual inspections and
19 you can see what's on the outside pretty easily. And
20 that's about as far as you can go. There are some
21 requirements for inspections during renewals, but
22 they're not particularly detailed.

23 We think that this is an area that could
24 be sort of a growth industry. There's a lot of new
25 technologies that may be available to monitor

1 different components with different techniques or to
2 have specific inspections for specific degradation
3 phenomena. So we think some further research in this
4 area could be warranted.

5 There's possibilities that you could begin
6 sort of building in monitoring techniques into new
7 cask technologies as you go forward.

8 MEMBER BLEY: What kind of renewals are
9 you talking about?

10 DR. RUBENSTONE: Again, the initial terms
11 were generally 20 years, you can get a 40-year term
12 now. So the application --

13 MEMBER BLEY: So it's the license renewal?

14 DR. RUBENSTONE: Right. But, you know, if
15 new technologies come up, you know, if we become aware
16 of some phenomena we don't wait until the next renewal
17 period. We certainly bring it to the industry's
18 attention. But I think this is a good time to start
19 developing these techniques. And especially as
20 sensors have gotten better, smaller, more easily in
21 place. I think there's things that are available now
22 that certainly weren't available when dry casks were
23 first developed in the 1980s.

24 MEMBER BLEY: Visuals they do with remote?

25 DR. RUBENSTONE: Generally if there's some

1 visual on the outside, there have been some inspection
2 with cameras put in, you know, within the concrete
3 structures. In general these structures were not
4 designed to promote inspection or monitoring.

5 MEMBER BLEY: Because that wasn't a
6 requirement.

7 DR. RUBENSTONE: It wasn't a requirement.

8 MEMBER BLEY: So maybe all they're looking
9 at is the overpack?

10 DR. RUBENSTONE: I think that's the most
11 obvious, but you can get into some parts of it. And
12 I think John will talk about this in some detail too.

13 MR. EINZIGER: There's a few monitoring
14 requirements. If it's a welded system they have to
15 monitor that they're not leaking. They have to
16 monitor that no birds are nesting in the outlets to
17 change the temperature. They have to monitor that
18 they're not getting a dose at the site boundary. But
19 really they're relatively small monitoring criteria.

20 We're interested in can we monitor what's
21 happening inside a sealed canister in terms of fuel
22 degradation, in terms of other mechanisms. Can we
23 determine what's happening on the surface of the
24 canister, which is inside the overpack. And as John's
25 going to tell you that's no easy task. We're

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1 interested in how good is visual examinations. We're
2 interested in how do you monitor the state of the
3 rebar in the concrete to make sure that it's not
4 having degradation. Or in the concrete that's incased
5 in stainless steel.

6 NRC is not intending to do research to
7 develop monitoring techniques. Our research is going
8 to be into what's the ability of monitoring techniques
9 to detect, what criteria should be put on them, what
10 monitoring would be desirable? How do we know what
11 the monitoring is doing in order to tell the inspector
12 see if they're doing this monitoring correct. Or are
13 they doing that monitoring correct or how often should
14 monitoring be done.

15 DR. RUBENSTONE: So those are the three
16 which we think, if we do work in those areas it could
17 help inform any number of things.

18 So this is the next set and we broke them
19 up just so you could read them on the slide, but
20 they're not really that much lower in what we
21 considered priority. And again I've grouped some of
22 these. They're broken out in more detail in the
23 report itself.

24 This first group is what we've talked
25 about as being driven primarily by the stress on the

1 cladding. So there are a number of cladding
2 degradation phenomenon. Propagation of preexisting
3 flaws, fatigue and low temperature creep. But I think
4 --

5 MEMBER ARMIJO: How can you get fatigue in
6 a static environment?

7 DR. RUBENSTONE: I think this covers
8 transportation also.

9 MEMBER ARMIJO: Oh, this is only during
10 transportation where there could be some cyclic
11 loading on the components?

12 MR. EINZIGER: There's two types of
13 fatigue. One is the fatigue during cycling, loading
14 and transportation. The other one that I think we
15 analyzed was the thermal fatigue due to cycling from
16 the change in the ambient temperature.

17 DR. RUBENSTONE: You have an initial
18 thermal heating of the material.

19 MEMBER ARMIJO: That's really pretty tiny.

20 MR. EINZIGER: Sam, this is an awful long
21 time period. And as you're well aware things that
22 don't occur, don't appear very active in the short-
23 term, if you go for a long-term they can build up.

24 MEMBER ARMIJO: Well when somebody does
25 some calculations I think you'll, that's really tiny

1 stresses that you could get from ambient temperature
2 gradient.

3 DR. RUBENSTONE: But they all depend on
4 the stress question. So that's where the stress
5 questions --

6 MEMBER ARMIJO: Yes, so somebody's got to
7 come up with a good stress story.

8 DR. RUBENSTONE: You get with the stress
9 first and then you can see how important some of these
10 are.

11 MR. EINZIGER: Sam, because the things are
12 on this list does not mean that the NRC is going to
13 start with a large experimental program. Some of
14 these items could be handled with modeling. Some
15 could be handled with analysis. Some will require
16 more data. Some of them are only suitable for a
17 particular type of material, for instance the neutron
18 absorber one. Really the main concern there is those
19 neutron absorbers that are also being used for
20 structural components.

21 DR. RUBENSTONE: Yes. So these other ones
22 address some of the other materials that are inside
23 the canisters, especially over long-term. Neutron
24 absorbers are also of interest in some wet storage
25 issues. Keep in mind dry storage is generally higher

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1 temperatures so we have different sorts of phenomenon
2 that could be going on.

3 Microbial influenced corrosion is another
4 one we were just trying to define under what
5 conditions is this something we need to worry about.
6 That's clearly a lower temperature issue, I think.
7 Darrell's done some work in this area.

8 MEMBER ARMIJO: Are you looking at spacer
9 damage or degradation, do you know --

10 DR. RUBENSTONE: If you're talking about
11 the grids?

12 MEMBER ARMIJO: A lot of these spacers --
13 Yes.

14 DR. RUBENSTONE: Yes we are looking at it
15 as part of the fuel assembly hardware corrosion and
16 fatigue embrittlement. There are a number of projects
17 underway, especially overseas, we're trying to get
18 into those programs at least to get that data. And we
19 are actively, I think we're still pursuing with the
20 industry to try to get a radiated grid for testing
21 purposes.

22 MEMBER ARMIJO: Well there's all sorts of
23 designs that have grids using Inconels using zirconium
24 alloys, it's a huge number of variables there.

25 DR. RUBENSTONE: Understand.

1 MEMBER ARMIJO: And they are thin
2 components. So if there's a degradation problem. And
3 they're supporting these things, that's why I asked
4 the question about the horizontal loading.

5 DR. RUBENSTONE: Yes, I mean that's where
6 those small components can make a difference when
7 you're talking about changes in geometry and adding
8 different stresses to other components.

9 MR. EINZIGER: Well there's not only the
10 supporting geometry, there's also the relaxation of
11 the springs and grids that will affect how they hold
12 things even in a vertical drop.

13 DR. RUBENSTONE: And then the concrete
14 degradation. Concrete seems like a straightforward
15 issues, but as Bob said, there are a lot of places in
16 the concrete where you cannot easily inspect it. The
17 rebar question over long periods of time, there have
18 been some observed degradation issues in concrete
19 related to freeze/thaw.

20 Again, if you can see it easily it's
21 pretty easy to detect and mitigate but what you don't
22 want to do is get to a state where you try to pull a
23 canister out of something and see that the concrete is
24 sagging. Or it breaks when you try to move it. So
25 this gets back to the monitoring question, if there's

1 ways of detecting concrete issues that come up early
2 on, you know, see them before they've gotten to the
3 point where they're actually challenging the
4 structure.

5 So that's really the essence as far as
6 we've gotten in this report. As we've laid out these
7 technical issues. We're awaiting comments from the
8 public, from industry, about whether we've missed
9 things. If we've mischaracterized it. And we'll
10 finalize this report.

11 There's another class of areas that we are
12 just starting to examine which are not purely
13 technically driven but they certainly have technical
14 components to them that we're calling regulatory
15 areas. And one of the next projects we'll be starting
16 on is sort of an equivalent regulatory analysis if
17 there are additional areas that need to be looked at
18 systematically and what changes might be needed.

19 Some of these issues have been around for
20 some time and they're even being looked at in a
21 current framework. Decommissioned sites was a big
22 focus of the Blue Ribbon Commission discussion. The
23 requirements for possibly being able to handle
24 canisters or move canisters in a site where the only
25 thing that exists now is a dry storage facility.

1 Questions of whether physical security
2 regulations would need to be changed as one moves out
3 for very long periods of time. There's a current
4 rulemaking going on for physical security
5 requirements, upgrading those at dry storage
6 facilities. When that is completed the answer will be
7 looking at any issues that might come up for extended
8 storage.

9 Risk informing is always a big issues when
10 everyone looks at, you know, when we look at our
11 regulations. As I said these regulations are very
12 much performance based. They're not strongly risk
13 informed at that time. WE have not been directed by
14 the Commission to go full-bore on risk informing but
15 we're certainly using risk information as we go
16 through this.

17 MEMBER BLEY: Jim?

18 DR. RUBENSTONE: Yes.

19 MEMBER BLEY: Back to that NWTRP report.
20 They had a couple recommendations that I kind of like,
21 but I just wonder if it's even possible because of the
22 way the regulations are organized to do it. And the
23 first was that it could be helpful in managing
24 extended dry storage if the regulations were revised
25 as an integrated set. And that's integrating

1 transportation and storage, which seems to be the
2 trouble. At least to me administratively troublesome,
3 part of that. And risk informing them as you're
4 saying now. Any comments about that?

5 MR. EINZIGER: There's a number of
6 activities going along in that area. Internationally
7 the IAEA had a group looking at integrating storage
8 and transportation regulations. For dual casks that's
9 a major issue over there because they have a lot of
10 those types of casks. Here in the United States we
11 have a number of groups within NMSS and especially in
12 the SFST Division that are looking at integration.

13 And integration does not mean necessarily
14 making them all in one regulation. It may mean a
15 separate regulation for spent fuel. Because remember
16 now the regulations are covering the movement of
17 radioactive material. They're not isolated to spent
18 fuel. It may mean leaving the regulations the way
19 they are and just changing the guidance. It may mean
20 just fine tuning the regulation so they're a little
21 clear on what's meant in the words.

22 There's a variety of ways of attacking
23 this issue. And the best I think we could say at this
24 point is all of them are being considered to see if
25 there's any advantage in taking any action on any of

1 them.

2 MEMBER BLEY: Let me ask one other one,
3 because again it was triggered by some of their
4 recommendations at the discussion, and this is an open
5 meeting so I know you can't peruse this much. But
6 they also, in the same breath, talk about security and
7 a risk informed approach there. There must be some
8 interplay between the safety and security and these
9 areas of uncertainty that you have. And are they
10 being looked at completely separated or is that being
11 looked at as in the way they exist in the real world
12 and maybe a coordinated?

13 DR. RUBENSTONE: I think we're trying to
14 keep them together as much as possible. There's not
15 really an active work right now on the physical
16 security aspects. That will come probably, like I
17 said, when they finish the current rulemaking, which
18 could be two years. But we'll still have time to look
19 at that. There's certain assumptions that are made
20 about the fuel and the properties of the fuel. And
21 the security analysis --

22 MEMBER BLEY: So that would be a place
23 these would come together?

24 DR. RUBENSTONE: And then we have to say
25 are those still valid assumptions if you're out 50

1 years from now.

2 MR. EINZIGER: Having worked on the
3 security aspects prior to coming to the NRC I can tell
4 you some of the things that we have identified as
5 degradation mechanisms, will have implications for the
6 analysis that were done for security. We have not yet
7 sat down with the security people to discuss those
8 implications. And any discussions in that line would
9 be of a classified nature.

10 MEMBER BLEY: I understand that. But the
11 idea that they'll take advantage of the same
12 information as --

13 DR. RUBENSTONE: Right. Right. That's
14 what I meant, that these are regulatory areas but they
15 have to be informed by what we learn on the technical
16 side.

17 So what are our next steps? Certainly the
18 first step is finalizing this report when we get the
19 comments in. Two things we're developing right now in
20 parallel are the research plan for what NRC is going
21 to do. And some of these investigations are already
22 begun. The best example is the stress corrosion
23 cracking, trying to define the actual conditions from
24 some lab experiments. But there are a couple of other
25 things that we've started on.

1 And we're going to lay out a research plan
2 that shows what NRC sees as its main areas over the
3 next several years. And that will, I think, help
4 inform this bigger picture of well, who's going to do
5 the other components, because there are certainly
6 other players with a strong interest in this and most
7 of them will be represented in the second half of the
8 meeting.

9 And we certainly are going to monitor
10 what's going on by all other groups because we're not
11 claiming that only the things we do are the ones we
12 believe. So we want to build and keep the dialogue
13 going.

14 MEMBER BLEY: You haven't talked about
15 burnup since your original opening remarks. Is there
16 an issue with respect to burnup and some of the
17 phenomenon that --

18 DR. RUBENSTONE: Well there's sort of a
19 whole family of burnup questions that have come up
20 even in the current context and they don't go away
21 over time. And Bob can give you the short synopsis.

22 MEMBER BLEY: They weren't on your final
23 list of big things to look at, that's why I'm asking.

24 MR. EINZIGER: Well, burnup per se is not
25 a degradation phenomenon.

1 MEMBER BLEY: Exactly.

2 DR. RUBENSTONE: But when you're looking
3 at how fuel behaves and all aspects, you need to
4 consider what's being stored. And if it's more and
5 more high burnup fuel then that will color how you
6 look at the phenomenon.

7 MR. EINZIGER: As you increase the burnup
8 of the fuel you change the properties. We know that
9 some of the degradation mechanisms will change with
10 higher burnup if the stresses for those changes are
11 available. That's why we didn't identify burnup per
12 se as an issue, but rather it's sort of incorporated
13 in these particular, some of the mechanisms that we
14 did look at.

15 For instance, we're interested in fuel
16 swelling but it's really a high burnup issue, not a
17 low burnup issue just because you don't generate as
18 much product decay into the helium. So it's buried in
19 there. It's definitely an issue. Things that some of
20 these mechanisms that we don't consider for low burnup
21 are high burnup issues.

22 MEMBER BLEY: Is this a scenario where
23 there's sufficient experimentation and existing
24 research? Or is this a place we need actual
25 experiments to get a better feel for what might be

1 happening?

2 MR. EINZIGER: I think that in some cases
3 we have a feel for what's happening. For instance,
4 with respect to hydride reorientation. I think we
5 have enough feel t know what the questions are for the
6 NRC. That doesn't mean that there's enough research
7 out there to answer the questions. But once we, as I
8 said before, once we know that we have a question then
9 the responsibility for answering that question shifts.

10 For other questions like delayed hydride
11 cracking, is there an issue? Does more work have to
12 be done? We don't think there's a current issue. We
13 think there may be a further issue down the line, but
14 that issue is going to be dependant on whether there
15 is a suitable stress to drive it.

16 And so our question to start with is not
17 do we have delayed hydride cracking and should we have
18 an experimental program to look at it, but rather do
19 we have a stress that's going to drive it in the first
20 place? So there are areas that need further aspects
21 done.

22 MEMBER BLEY: I'll ask again when the
23 others are up. But I'll ask you in case you have an
24 idea on it. Does DOE have a role in this research or
25 does it belong to the industry? You don't really

1 care, I mean, when an application comes in it's
2 whatever's there to back it up. But if you can just
3 give us some information on that I'd appreciate it.

4 MR. EINZIGER: There's two parties in this
5 whole game. There is the person that holds the CFC
6 for the cask, and has to defend the cask. And there's
7 the person who's going to use the cask. As far as I
8 know DOE has not held a CFC and built any casks for
9 commercial fuels. That may be wrong, but I think
10 that's the case. And the other part of it, so far DOE
11 doesn't hold the fuel, other than a little bit of fuel
12 I think that was part of test programs.

13 DR. RUBENSTONE: Well we've got the Idaho.

14 MR. EINZIGER: Well that's what I'm
15 saying, that's the test programs. And I don't know
16 that they are a shipper of record. If the utilities
17 are the shipper of records they're the one that's
18 going to have to produce the data. If DOE is the
19 shipper of record they're the one that's going to have
20 to make the case. I really don't care.

21 MEMBER BLEY: We'll look forward to
22 hearing from them. But before we break I wanted to
23 get that out.

24 DR. RUBENSTONE: Yes, at NRC the position
25 is that we need the information to make these

1 decisions. And where it comes from, but I think DOE
2 probably feels it has some role in this.

3 MEMBER RAY: What we're talking about is
4 identification and prioritization of the technical
5 information for potential regulation. How do you see,
6 so we're just involved in the very early stages here,
7 but what's the next step from a regulatory standpoint?
8 Are you going to produce a final report or how does it
9 proceed from this phase that you're involved in now?

10 DR. RUBENSTONE: What we have laid out to
11 the Commission, and we recently sent up a annual
12 status paper on this issue. So we're on record now of
13 saying what our plans are. We are shooting to, by
14 2018, to know what changes need to be made in
15 regulations. And if they're small changes to have
16 started that and starting on changes in guidance.

17 So our step wise is first identify the
18 needs, lay out the research plan, gather that
19 information that we think NRC needs specifically.
20 Assess any regulatory issues that fall out of that and
21 then make the decision. So the finalization of this
22 report is the immediate first step that says we've
23 identified these are the needs.

24 We will be putting out then, subsequently,
25 our research plan saying these are the issues we're

1 addressing, this is when we expect to get results.
2 And then the somewhat parallel but not exactly the
3 same, prioritization of potential regulatory issues.
4 Now the regulatory issues are evolving in parallel
5 with some of this current licensing process
6 improvement activities that are going on.

7 So we're not going off and saying we're
8 going to make these changes just for extended if
9 there's something that could help in the current
10 framework as well. So like I said, the next step is
11 the final of this report, the research plan and then
12 as the results come out we'll probably be issuing
13 individual results as we get enough and then maybe a
14 roll up at the end saying here's a summary of
15 everything we learned with a bibliography of all the
16 reports that have come out along the line.

17 MR. EINZIGER: Over the next five years we
18 expect to be doing separate effects testing on various
19 mechanisms, or modeling, as it may require. And based
20 on that and other information we get, make a decision
21 whether there's any technical change to technical
22 guidance. But ultimately we're going to be asking the
23 licensee to back up these prognostications with some
24 hard fact that what we think is happening really is
25 happening.

1 And that gets back to John's question of
2 somebody along the line is going to have to produce
3 some data to show us that we know what's really
4 happening on a cumulative basis by some actual,
5 looking at some fuel under actual conditions. Looking
6 at some casks under actual conditions. Looking at
7 some canisters.

8 MEMBER RAY: Yes, well it sounded like
9 maybe this research plan you referred to implied, well
10 it was up to the Government to answer all these
11 questions.

12 DR. RUBENSTONE: No.

13 MR. EINZIGER: No, we want to answer as
14 few of them as we have to answer. We want to depend
15 on other people as much as possible.

16 DR. RUBENSTONE: Yes, what I meant by the
17 research plan would be, from the large set of
18 questions we've posed in the report how is NRC going
19 to pick a subset that we think we need to do the work
20 on. And that's clearly a subset of everything that's
21 laid how.

22 MEMBER ARMIJO: How do you pick the subset
23 that are important? That, you know, that's really to
24 me the first thing is say these are important. These
25 are a zillion other phenomenon that people can get.

1 MR. EINZIGER: Well that's why we have the
2 first six laid out there.

3 DR. RUBENSTONE: I mean that's our first
4 pass. And I think what we're going to refine is --

5 MEMBER ARMIJO: Then having said that,
6 what data needs to be made available so that you can
7 resolve it.

8 DR. RUBENSTONE: Right. I mean it's not
9 that different than addressing any technical issue in
10 that you first define what the issue is. That alone
11 doesn't tell you what the specific data needs and the
12 data needs don't alone tell you can this experiment be
13 done or can this analysis be done. So that's the
14 sharpening of the pencil that we're getting into now.

15 MEMBER RAY: Okay, but I felt better after
16 what Bob said. I mean, you can say this is the extent
17 of our knowledge and therefore if you guys want to
18 extend the license it's up to you to show that it's
19 okay, speaking to the licensee or to whoever has the
20 stuff. But because of the way this is all viewed
21 ultimately, I suppose as a Government problem, I was
22 wondering if you were thinking well no it's up to the
23 Government not only to figure out what the answers are
24 that we need but also to go find them.

25 MR. EINZIGER: I guess the simple way to

1 put it is what I tell industry all the time. We're
2 both seeing different sides of the same cup. We look
3 at the cup and say what are the questions. You have
4 to look at the cup and say what are the answers.

5 MEMBER RAY: Well that's fine. I can buy
6 that.

7 DR. RUBENSTONE: And keep in mind that we
8 are doing this now so we're ready for problems that
9 may crop up over the next number of decades. This
10 isn't the end of the story but we didn't want to just
11 sit around and let it sit. Because some of these
12 projects may involve sort of long-term experiments or
13 monitoring of existing systems or future deployed
14 systems over decades to make sure that we are in fact
15 capturing the right phenomenon.

16 MEMBER ARMIJO: What about the people that
17 are trying to get a 20-year extension to their current
18 license right now? What do they have to, you know,
19 given all these questions and the potential need for
20 new data, are they out of luck? Or is there
21 resolution? Is there some way to --

22 DR. RUBENSTONE: I wouldn't say they're
23 out of luck. There have been extensions already
24 granted and there are current actions moving forward.
25 This is helping define the kinds of questions that are

1 being asked and kind of information we're getting
2 back. I don't think any particular one is at an
3 impasse.

4 There are, certainly I won't diminish the
5 fact that there are certain current issues being
6 addressed and they involve things like high burnup
7 fuel. They involve some of these stress corrosion
8 cracking issues. But I don't think anyone is at a
9 sort of out of luck position out there.

10 MEMBER ARMIJO: Well in some cases the
11 research would confirm judgement that you've already
12 made that there was or was not a problem.

13 DR. RUBENSTONE: Right.

14 MEMBER ARMIJO: And that's valuable. But
15 I'm just saying that if someone comes in and says,
16 here's my cask, it's really old fuel, it's been
17 sitting there for 20 years, it's not in a marine
18 environment, you know, just the stuff inside, and I
19 really don't have any more information than I had for
20 you than what I had 20 --

21 MR. EINZIGER: We look at their overall
22 case. We have had a number of applicants come in for
23 low burnup fuel. We allow them to use the examination
24 of the fuel that was out in Idaho, after 15 years on
25 the low burnup fuel, as evidence that yes we thought

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1 we knew what we were doing and yes this confirms it.
2 And so we don't question it very much.

3 If they're in a non-marine environment we
4 may ask them a question if they're in an industrial
5 environment. I don't know what would happen to casks
6 if they were sitting in Akron. Nothing against Akron.

7 MEMBER ARMIJO: There is very little
8 industry --

9 MR. EINZIGER: What's that?

10 MEMBER ARMIJO: I don't think there's too
11 much industry in Akron.

12 DR. RUBENSTONE: Maybe not the best
13 example.

14 MR. EINZIGER: We take a realistic point
15 of view. Now if they come in and there's issues that
16 they don't have answer to we look at their arguments.
17 We discuss what their points are. We try to tell them
18 what we need. We try to give them some hint of ways
19 to go about getting this data. We try to give them a
20 number of alternatives, those alternatives might be
21 take a different approach to it.

22 It may be we're going to put some
23 restrictions in your CFC. But ultimately they've got
24 to convince us that they can meet the Part 72, or if
25 it's a transportation Part 71, license for the fuel

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1 that's been in that storage for some period of time,
2 recognizing that what you put in may not be what you
3 put out.

4 There's different ways of doing it. The
5 Japanese have taken an approach that at 400 degrees C
6 we have a change in the fuel condition, we get hydride
7 reorientation that changes the mechanical properties
8 and we don't want to deal with that. So they took the
9 step and says we're not going to go up to 400 degrees
10 C. We're going to limit our temperatures to 275 C.,
11 where very limited hydrogen goes into solution. We
12 don't have a hydrogen reorientation effect. And we're
13 going to make the assumption that since we don't have
14 this effect if we know what we put in storage that's
15 going to be the same thing 50 years later.

16 Now we could take that approach too. Or
17 we don't even have to take that approach. If a vendor
18 decided that from now on they wanted to limit the
19 storage temperature to 275 and try to make the
20 argument that the Japanese made, they're free to do
21 that.

22 MEMBER ARMIJO: If they recalculate. You
23 know, the 400 was a bounding temperature, right?
24 That's a maximum temperature they could go to. So
25 they calculated the cladding temperatures, using

1 whatever model. Probably worse, not worst case but a
2 lot of margin probably. And a lot of this fuel that's
3 out there is really old fuel, doesn't have much decay
4 heat. So you probably have a lot of fuel out there
5 that's already at pretty low temperatures that started
6 out at low temperatures.

7 MR. EINZIGER: It may well be and they
8 might do those recalculations. It also may be that
9 the points in the fuel that are going to see the
10 higher temperatures and possibly have a defect like
11 hydride reorientation, that's not the part of the fuel
12 that's going to be at the low temperature when you go
13 to transport it or you go to do extended storage. It
14 may be that that part of the fuel is still high enough
15 so it hasn't had any change in ductility.

16 So that's one of the drivers for us
17 looking at modeling of the more realistic temperatures
18 with more realistic properties. Not so much to give
19 the industry a tool, we're expecting the industry to
20 actively try to hone their models better. We're
21 looking at it as a tool for our reviewers to use to
22 check on the calculations of temperature that they're
23 getting from the industry.

24 MEMBER ARMIJO: Thanks.

25 DR. RUBENSTONE: The next couple slides

1 are just about what came out in the Blue Ribbon
2 Commission Report. And I think we can go through
3 those relatively quickly.

4 There were eight key elements and their
5 recommendations in their January final report. I've
6 picked out three that are relevant, I think, for these
7 issues. The first overarching one was this new
8 consent based approach to siting. And that included
9 a variety of facilities including potentially what's
10 in the next point, one or more consolidated storage
11 facilities. And they also stressed prompt efforts to
12 prepare for eventual large scale transportation.

13 The second one I think we had brought up
14 earlier and some of the implications. Staff has
15 prepared for the Commission our, sort of, what are the
16 implications for NRC from the BRC recommendations if
17 they are in fact implemented. That was a briefing
18 back in April. And there's a report that's in ADAMS
19 there. There is expected a report back from DOE to
20 Congress. And maybe Jeff may mention that as he talks
21 about DOE.

22 But the implication that come up is the
23 question of consolidated facilities could lead you to
24 multiple transportation stages. Sort of overarching
25 belief over the years has been generate the fuel, put

1 it in storage, move it once, it's disposed. That may
2 not be an accurate capturing. So you may have things
3 that have been in storage for some time, they are then
4 moved, they go in storage again and then will be moved
5 a second time.

6 And then how long those different time
7 periods depends on where you are in the stage and that
8 then has implications for the state of fuel, you know,
9 when it enters into the first transportation stage
10 you've got one set of issues. If it's been stored for
11 decades and then is transported you may have some
12 additional different issues.

13 And certainly moving things from a static
14 facility, taking them on the road, putting them back
15 in storage, what's the state of the fuel. That's a
16 question that needs to be addressed. You may also end
17 up with multiple stages of handling, either just
18 handling canisters, moving them between different
19 overpacks or potentially if things are in storage long
20 enough, having to remediate and change the actual
21 storage capability.

22 CHAIRMAN RYAN: Jim, could you describe
23 the database that exists to kind of get at or answer
24 or maybe even address some of the questions you've
25 just raised? I mean how many examinations of long

1 standing storage fuel or fuel that's been moved and
2 reloaded or, you know, what's the database --

3 DR. RUBENSTONE: Pretty limited, Mike.
4 The example Bob gave earlier about the low burnup
5 demonstration experiment that was done at Idaho, and
6 it's still ongoing, there's still fuel in that
7 storage, was some moderate transportation of
8 relatively young fuel, leaving it for 15 years,
9 opening it up, pulling some materials out to look at.
10 You know, that's valuable data.

11 CHAIRMAN RYAN: Oh absolutely, yes.

12 DR. RUBENSTONE: But there are some
13 limitations of it. The Japanese did periodic
14 examinations of reopening canisters in storage. That
15 has some relevance but it's not directly mappable
16 because of the offset --

17 MR. EINZIGER: Low temperature. It's very
18 low temperature. Low burnup.

19 DR. RUBENSTONE: They have low burnup and
20 they also have this lower temperature constraint and
21 --

22 CHAIRMAN RYAN: Well it's a start though.

23 DR. RUBENSTONE: So it is some data.
24 There's some discussion of other things. There is
25 some information from the French who do transport

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1 things relatively early on in the cycle but on a
2 relatively larger scale, going from the power plants
3 to the reprocessing facility. So there is some
4 information of what the fuel looks like when it
5 arrives there.

6 Again, it's not perfect analog for this
7 but it can be used. There are discussions, and I
8 think this will come up in the second group of talks,
9 about another demonstration project that could give
10 some information after a storage period could have
11 some sort of realtime monitoring information
12 available.

13 CHAIRMAN RYAN: Yes.

14 MR. EINZIGER: There's lots of data out
15 there on various topics that applicants like to quote.
16 Usually where they get into trouble is when you say,
17 is this data really applicable to the system. For
18 instance, the French have transported a lot of fuel,
19 as Jim has said, from the utilities to Le Havre. Most
20 of that transportation occurs in the 350 to 450 degree
21 C range. So is that data applicable to fuel that's
22 going to be transported in the 100 degree range?
23 Probably not.

24 DR. RUBENSTONE: And then there are all
25 these separate effects tests. And there has been a

1 fair amount of work on specific questions that have
2 been addressed. And some of that data is more
3 applicable than others. You really have to look at it
4 case by case. So there's a fair amount out there.
5 There are some holes, and that's something we came up
6 with that it would be nice to get something that's had
7 this history, looked at at this level of detail.

8 CHAIRMAN RYAN: Thank you.

9 DR. RUBENSTONE: And then the last bullet
10 there, I think we'll all agree, is there probably will
11 be statutory changes. There have been a number of
12 discussions of things being introduced. There's not
13 a lot of action yet from Congress but we're keeping
14 our ear to the ground. Well certainly many of the
15 recommendations of the Blue Ribbon Commission would
16 require statutory changes up front.

17 So NRC's regulations, they match the law,
18 so that may drive some changes in our regulations as
19 well. And I think, yes, just to wrap up. This is
20 where we stand. We hope we've met your current needs
21 and we are certainly open as we progress and move
22 through these various steps to come back and tell you
23 what we've found.

24 I have some backup slides, they're mostly
25 just diagrams and pictures of different systems if we

1 wanted to get into the details of them.

2 CHAIRMAN RYAN: And I guess what I would,
3 thinking ahead a little bit, you know, the Full
4 Committee meeting, you're really reporting on work in
5 progress. This is not a final product by any means.
6 You know, these bullets to me kind of summarize here
7 we are at this point. We've done these things and
8 here's where we are going forward a little bit.

9 If you could just summarize and say what
10 are the top three or four things you want next time
11 you come and see us. What do you want to have
12 finished at that point? What are your high priorities
13 for the NRC staff? I know, I heard from industry reps
14 on some other activities, but what are you looking at?

15 DR. RUBENSTONE: I think my highest
16 priorities, I think in finalizing this report we can
17 do that. But getting this research plan in place so
18 we really have defined, over several years, what are
19 we expecting. And what can we realistically do. And
20 then opens it up and I think it further informs the
21 industry of what's on their plates. So getting that
22 research plan together.

23 Getting a systematic regulatory analysis.
24 I gave you some bullets of areas we're looking at,
25 that's certainly not the final word. And those are

1 the two things that I see us getting done. I don't
2 want to give you dates on when we're going to have
3 those.

4 CHAIRMAN RYAN: No, no. I'm not looking
5 for dates. I'm looking for comments.

6 DR. RUBENSTONE: I think those are the
7 next two things. And then certainly as we move
8 through the research that we're doing and we see what
9 other groups are doing there may be opportunities that
10 come in and say well, now we know what the pressure is
11 going to be and the stresses are going to be on the
12 cladding. So we're doing this or we're not doing
13 that. That may be a point that we could come back --

14 CHAIRMAN RYAN: So you might be able to
15 fine tune your research program based on what you
16 learn from others as we go forward?

17 DR. RUBENSTONE: Absolutely. And we've
18 mostly looked at U.S. activities, there is a lot going
19 on in the rest of the world. We're involved with a
20 number of activities with IAEA. NEA is starting up an
21 activity on this area. A number of individual
22 countries have it. It's hard to find a country that
23 has nuclear power generation that isn't seeing
24 extended storage as a challenge.

25 CHAIRMAN RYAN: Would you say that the NRC

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1 is well engages in all those process with others or
2 should that be enhanced?

3 DR. RUBENSTONE: I think we are well
4 engaged. I think you can always do more, but where we
5 are now we seem to have our involvement with the NEA
6 activities, the IAEA activity and some bilaterals.
7 And you know some countries are further along that
8 others.

9 CHAIRMAN RYAN: Yes.

10 DR. RUBENSTONE: Like Japan and Korea
11 particularly are doing a lot of work. The Spanish are
12 getting very much engaged in this. The Germans,
13 although they have very much a narrower set of cask
14 designs, they're all bolted systems, they've done a
15 lot of work in that area. The UK is just realizing
16 that they have a problem I think and they are trying
17 to catch up. So we're trying to stay in good with the
18 right players.

19 MEMBER SCHULTZ: Jim, are those
20 timeframes, the international activities, are the
21 timeframes that they're viewing similar to what we've
22 discussed today or are they really looking at
23 extensions, 20 years, 40 years?

24 DR. RUBENSTONE: I think it differs in
25 some of them. Some of them are looking at shorter

1 periods.

2 MR. EINZIGER: We're one of the few
3 countries that licenses storage without mandating that
4 transportation be licensed at the same time.

5 MEMBER SCHULTZ: Correct.

6 MR. EINZIGER: If you looked at the
7 international spectrum the timeframes that are
8 considered vary over the map. The short is 50 years.
9 The official IAEA declaration of long-term storage is
10 more than 100 years. So it varies over the map. And
11 that somewhat defines the issues that they're dealing
12 with.

13 Also what their path forward somewhat
14 defines their issues. For instance, as you heard, one
15 of our top priorities is marine stress corrosion
16 cracking of the canister. Now if you look at the
17 priorities that the Spanish have, they don't even list
18 that because they're building a centralized storage
19 facility essentially in the middle of the country.
20 Nowhere near a marine site, so they don't care.

21 On the other hand if you look at the
22 British program it's very much an issue with the
23 British program. And even some of the fuel issues are
24 higher with the British program than our because the
25 Brits count on the cladding as a barrier. For us the

1 cladding is only a defense-in-depth. The canister in
2 storage and the overpack in transportation are the
3 primary barriers.

4 So depending upon the individual country's
5 priorities, there's different timeframes, there's
6 different research they're doing. What we're trying
7 to do is to make we're on top of it to make sure when
8 they get results we use those results in our program.
9 Let them guide what research we're doing, what
10 research we don't have to do.

11 If they're having programs that are
12 looking in effect for some other reasons, let's say
13 for the reactor purposes, and we can piggyback on that
14 for some reasons. We're trying to get involved with
15 piggybacking on them so that we could either use the
16 same materials or the use the same people or the same
17 facilities to minimize the effort that we need to do.

18 MEMBER SCHULTZ: Thank you.

19 CHAIRMAN RYAN: Thank you. Any other
20 questions? Or we're kind of right on time for our
21 break so we'll go ahead unless there are any other
22 questions? Comments? Going once, going twice. Okay.
23 We'll break until 2:45. I'm sorry until 3 o'clock.

24 (Whereupon, the above-entitled matter went
25 off the record at 2:42 p.m. and resumed at 2:58 p.m.)

1 CHAIRMAN RYAN: Okay. We'll continue with
2 the agenda. I believe, let's see, Jeff Williams is up
3 from DOE.

4 (Off the record comments.)

5 CHAIRMAN RYAN: Jeff, welcome.

6 MR. WILLIAMS: Yes, I'm Jeff Williams, I'm
7 at DOE's Office of Nuclear Energy. I actually came
8 from the Office of Civilian Radioactive Waste
9 Management, where I was there for about 25 years or
10 so.

11 So anyway, as I was sitting there
12 listening to this I thought of a whole bunch of other
13 things to mention. I'm really focused on our R&D
14 activities is what I was going to talk about today.

15 So the way we're organized is we have nine
16 laboratories that are working for us and we're
17 providing them funding. And in this area primarily
18 PNNL, Sandia and Idaho are the biggest players in this
19 area. And so this is a new program that was developed
20 after the withdrawal of the Yucca Mountain license
21 application and the stopping of doing that program.

22 And so a report called the R&D Roadmap was
23 developed by NE that laid out sort of the mission of
24 all of the Office of Nuclear Energy and this used fuel
25 disposition program was part of it. And it lays out

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1 all the research that's being done related to
2 alternative geologies for repositories as well as
3 extended storage. And then more recently we've added
4 transportation.

5 So this is an area where basically where
6 we're just getting started. And so this talk here is
7 going to focus on the storage and transportation part
8 of our program. And this is, I'm going to talk about
9 the major activities and the collaborations that are
10 going on. And this is just showing that we're looking
11 at all the way from spent fuel assemblies up to
12 canisters to casks.

13 The recent focus has really been trying to
14 determine, well what do we do. And so our overall
15 objectives is to develop the technical basis to
16 demonstrate the used fuel integrity lasts for extended
17 storage periods. And develop a technical basis for
18 retrievability and transportation after the extended
19 storage. And also to develop the technical basis for
20 transportation of high burnup fuel.

21 The pictures here are sort of the same
22 way. Showing that we're looking at the nano scale,
23 small scale, all the way up to large scale and casks
24 and so forth. And that we're doing this through a
25 science-based engineering driven program. And how do

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1 we know we're doing the right things? Basically we
2 started off by doing a functional requirements
3 assessment. Then we conducted a technical data gap
4 analysis. And then we compared that gap analysis with
5 other gap analysis that were trying to identify data
6 that's needed in this area.

7 The Nuclear Waste Technical Review Board
8 did one. Bob and Jim just talked to you about the NRC
9 one. We've conducted external reviews of this work.
10 We worked closed through a program that John, I
11 imagine will tell you about, called the Extended
12 Storage Collaboration, or Cooperation one of them.

13 CHAIRMAN RYAN: Either one sounds correct.

14 MR. WILLIAMS: So anyway, I think we're
15 all trying to identify the same thing, where the focus
16 of the limited amount of money that does exist. And
17 DOE does have some, I think there was a question about
18 well what's DOE's role here. And we do have some
19 funding and Rod always tells me that it's my fault
20 because I stopped working on Yucca Mountain.

21 So anyway, we do have some funding. We do
22 have special capability with the labs. We have some
23 capability to do some fuel examination and so forth.
24 And we would like to replace some of the missing fuel
25 capability examination that used to exist. So based

1 on all this we think that we're doing the right kinds
2 of research right now.

3 And as a matter of fact we identified the
4 gaps -- Well I'll go into that in a minute. This
5 right here is just a listing of the major areas that
6 we're working in. We have a couple other smaller
7 areas but it's just the way we sort of organize our
8 work into R&D investigations, engineered materials
9 which is experimental, engineered analysis which is
10 computational, field testing and then transportation.

11 So these are the major activities that I'm
12 going to just go through. The first one called R&D
13 Investigations, this is a real complicated table here,
14 but it's just a picture out of a recent report that
15 we've put up. I'm not going to go into the details of
16 it but what we did is we did this initial gap
17 analysis. Where are the gaps, what data needs to be
18 gathered, which is what we shared with industry, NRC
19 and so forth.

20 And then this year, just in the last month
21 or so, completed what we called a prioritization of
22 these gaps. And what this table does is it goes down
23 through each one of the gaps on the left and then it
24 talks about the likelihood of occurrence. There's two
25 numbers there. The number on the left is near term

1 and the number on the right is farther term. And then
2 it shows what the consequence of something going
3 wrong. And then talks about whether it's easy or hard
4 to remediate.

5 For example, you can look down at concrete
6 and it's got a one. So concrete's easier to remediate
7 than if you had neutron poisons falling apart or
8 cladding annealing. And then we added all these up
9 and we got the importance for licensing. And we
10 identified whether they're high, medium or very high.
11 And this is a report that's, like I said, it's out in
12 draft right now. We have circulated it through the
13 escape committee that we're part of hoping to get
14 comments soon on it.

15 And I think we're identifying the same
16 type of gaps that everybody else is. And the next
17 step will be start to gather data, to get funding in
18 place to address these gaps. We're also doing things
19 such as developing aging management plans for storage
20 systems. Some of that work I think is due later on
21 this year. And we --

22 CHAIRMAN RYAN: In the report is there a
23 key that tells me what difficulty for remediation one,
24 two and three mean?

25 MR. WILLIAMS: Yes, one is easy. There's,

1 we put a key.

2 CHAIRMAN RYAN: What's easy mean? That's
3 \$60 million, \$5 million, \$20, what?

4 MR. WILLIAMS: Well relatively.

5 MALE PARTICIPANT: It's not a matter of
6 money.

7 CHAIRMAN RYAN: Well whatever the criteria
8 it's really vague what these mean. It's hard to
9 understand what's going on here without some detail,
10 but that's okay.

11 MR. WILLIAMS: Yes, well John's probably
12 read the report better than I have.

13 CHAIRMAN RYAN: Okay. Actually if you
14 could just give us a reference to where we can get the
15 report, that would be helpful. If we could give that
16 to Chris or to Rod -

17 (Simultaneous speaking)

18 MR. WILLIAMS: Well it's not publicly out
19 yet but we can sure get it to you. It's a draft
20 report that is undergoing a review, we're waiting to
21 comments back.

22 CHAIRMAN RYAN: Right, well whenever we
23 can have a public report we need to have it.

24 DR. KESSLER: Okay. We can do that.

25 CHAIRMAN RYAN: But you have distributed

1 it outside the --

2 MR. WILLIAMS: Yes, we've distributed it.
3 I mean, it's not up on a website somewhere where I can
4 point it for you.

5 CHAIRMAN RYAN: That's all right, if it's
6 a public report we'd like to have it.

7 MR. WILLIAMS: Okay. We'll get that to
8 you.

9 MEMBER ARMIJO: I'm sorry, I came in late.
10 I'm just trying to catch up. Just define consequences
11 difficulty for remediation.

12 MR. WILLIAMS: Yes, basically these are
13 relative. And it's just based on subjective judgement
14 where a group of people got together and said
15 relatively is this one harder than that one? And, you
16 know, as far as any more quantitative criteria --

17 CHAIRMAN RYAN: So these are opinions?
18 These are not based on any --

19 MR. WILLIAMS: Yes. Yes, these are
20 opinions of the people who work on this report.

21 MEMBER ARMIJO: How many worked on this?

22 MR. WILLIAMS: It's probably, I don't know
23 how many people, five or six people or so.

24 CHAIRMAN RYAN: Well not to cast
25 dispersions at your colleague, but how do we interpret

1 somebody's opinion? What's, I mean it's a pretty soft
2 sort of measure.

3 MR. WILLIAMS: Yes. Yes, except that the
4 good part is I think the things that we're identifying
5 as important for licensing are the same sort of things
6 that everybody else is identifying as important to
7 licensing. Like aqueous corrosion, okay? And so now
8 we're going to start up a collaboration to do some
9 testing. We're providing funding through EPRI. We're
10 hoping to get more funding to work on that further.
11 In addition --

12 MEMBER SKILLMAN: Isn't this somewhat
13 biased from the perspective that what is deemed as
14 very high likelihood of occurrence is really focused
15 around the canister or the cask and so the original
16 orientation here is the cask or the canister have to
17 carry today as opposed to some other characteristic of
18 the fuel. So this begins with the idea of good,
19 strong, robust steel encapsulation. That's where you
20 began, or that's where it appears that the team began
21 this.

22 ???: There isn't too much you can do with
23 fuel.

24 MR. WILLIAMS: Yes, well the fuel is
25 important from a transportation standpoint and a

1 retrievability standpoint I think, Bob or somebody
2 mentioned that.

3 MEMBER ARMIJO: But, Jeff, you can
4 retrieve anything. It's just how much work does it
5 take and how much cost does it take.

6 MR. WILLIAMS: Right, I think you got it
7 right.

8 MEMBER ARMIJO: And we can't assume, or
9 maybe we can as regulators, and require that something
10 remain in its pristine condition unchanged over 20
11 years on the basis of retrievability. Let's say it
12 embrittle, I'll make that an assumption. And that it
13 cracks a little bit during transportation. It's still
14 retrievable, it's just going to cost time, money and
15 effort to do it right.

16 So I'm still trying to catch up with how
17 we get to something that's worth funding that it's
18 really an issue that effects safety. And maybe I
19 better read the report again to really understand.

20 CHAIRMAN RYAN: I was going to say. I'm
21 stuck on the fact that this is a qualitative opinion
22 survey rather than anything else.

23 MR. WILLIAMS: Yes, that's right.

24 CHAIRMAN RYAN: And without understanding
25 the details of the report it's going to be real hard

1 to divine what these mean at this stage. So we get
2 this is a lead in to the report. Hopefully we'll get
3 the report and then we can go from there. Fair
4 enough?

5 MR. WILLIAMS: Yes.

6 CHAIRMAN RYAN: And in the interest of
7 time I suggest we move on.

8 MR. WILLIAMS: Okay. So the next one here
9 is engineer materials, experimental. And that's just
10 some work that we're doing in this area and the two
11 pictures show focus on cladding and the canister.

12 MEMBER ARMIJO: But this picture is, I've
13 got to object to that. You know, this is a picture of
14 cladding that's gone through a LOCA, simulated LOCA
15 transient --

16 MR. WILLIAMS: Right.

17 MEMBER ARMIJO: -- and it's been squeezed
18 and then it's not your normal.

19 MR. WILLIAMS: Right, and I was going to
20 say that.

21 MEMBER ARMIJO: It's not your normal,
22 normal fuel doesn't look like this at all.

23 MR. WILLIAMS: That's exactly what I was
24 just going to say, okay. Is that yes, this isn't fuel
25 but we do test this up to failure. And as a matter of

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1 fact this is tests that were initiated by NRC and then
2 we picked up the funding on it, I believe, last year.
3 On these ring compression tests.

4 CHAIRMAN RYAN: But not to put to fine a
5 point on it it's hard to make any, how does this help
6 inform our assessments of what we're doing?

7 MR. WILLIAMS: Well my understanding it
8 has to do with the hydride reorientation and trying to
9 determine how strong the fuel is. I don't know
10 whether -- And then the next bullet on the HFIR
11 cladding testing, that's not real fuel. That's gilded
12 fuel and they're trying to correlate between the ring
13 compression tests that are being done at Argonne with
14 real fuel to doped fuel and putting stresses on --

15 CHAIRMAN RYAN: Well, I guess what I'm
16 taking away is these are phenomenological studies that
17 were done in a laboratory situation, they're really
18 not designed to be in vivo real reactor fuel. They're
19 looking at parameters and features and events and
20 processes but not the behavior of a fuel element or
21 fuel elements in a storage cask for extended periods
22 of time.

23 MR. WILLIAMS: That's right.

24 CHAIRMAN RYAN: Okay, fair enough.

25 MR. WILLIAMS: And then the third bullet

1 down there talks about conducting also research on the
2 stainless steel corrosion test, which is being done
3 out of Sandia and in baths and so forth. And this is
4 another area that we're hoping next year to continue
5 work on this and provide additional funding to
6 continue this sort of work at this scale.

7 Let's see. Well you guys talked about the
8 real fuel and the real casks and I'm sure Rod and John
9 are going to talk about that some more. But we
10 haven't started a program on that yet, other than the
11 fuel that's up at Idaho that Bob talked about. The
12 low burnup fuel that's been up there forever that we
13 opened the casks back in the late '90s.

14 This is the next work account is called
15 engineering analysis and it's a computational thing.
16 In most cases we have several different what we call
17 work packages. One of the areas of work in this area
18 has to do with taking canisters, but there's been
19 emphasis on this for 20 years. It comes from the
20 Nuclear Waste Technical Review Board, BRC mentioned
21 about the compatibility or the standardization of the
22 canisters with disposal.

23 It was an issue that we thought we could
24 get our hands around when we knew what the repository
25 was. However, now that we don't know what the

1 repository is there's still be efforts, or interest in
2 pursuing this. And as a matter of fact our budget
3 this year we got a line item that told us we need to
4 continue to work on this. So we have a low-level bit
5 of work on looking at the compatibility of storage
6 casks.

7 As a matter of fact we even have started
8 up a program to look at what does it actually take to
9 dispose of existing dual purpose canister casks. If
10 you went to the Yucca Mountain program, everybody that
11 did the analysis out there would just say, oh they're
12 way too big you can't do it because of thermal
13 criticality reasons.

14 ??: Not everybody.

15 MR. WILLIAMS: Well --

16 DR. KESSLER: We're on record saying the
17 opposite.

18 MR. WILLIAMS: Well I mean, yes, okay. I
19 always --

20 CHAIRMAN RYAN: But others didn't.

21 MR. WILLIAMS: Yes. I always believed it
22 was primarily because they had an analysis for 21
23 assembly waste package and they, in order to meet our
24 schedules, they didn't have the ability to redo
25 everything. So anyway, we've started that. We

1 started that fresh. We're also looking at small
2 canisters for fuel that's not yet loaded. If you go
3 to any repository around the world none of them are
4 planning to do dispose of things this large. It
5 doesn't mean it can't be done.

6 So that's one item we're doing. We're
7 participating in this Calvert Cliffs inspection that's
8 going on by doing the thermal analysis on that. We're
9 trying to calculate the hydride reorientation and
10 basically how it, from a calculational standpoint, how
11 would you expect it to occur.

12 MEMBER ARMIJO: You have to have some
13 starting assumptions of what the stresses are on the
14 cladding from the pellet swelling or existing pressure
15 in the rod. Do you have a model for that?

16 MR. WILLIAMS: Yes, I'm sure they do. I
17 really don't know the details of it.

18 MEMBER ARMIJO: Is this Calvert Cliffs
19 canister inspection, is that somebody's actually going
20 to open up a canister?

21 MR. WILLIAMS: No, no.

22 DR. KESSLER: I'll talk about it.

23 MR. WILLIAMS: Yes.

24 MEMBER ARMIJO: All right.

25 MR. WILLIAMS: Okay. And then another

1 program we have is we want to look at what are the
2 stresses that are actually involved in transportation.
3 And so this is the work that's being done in
4 engineering analysis and we plant to continue that
5 into FY13. This next one, again is field testing,
6 which is just getting underway. We're writing a
7 storage/transportation R&D plan that defines the near-
8 term separate effects testing that's needed. So we've
9 laid out a plan that talks about actual tests on small
10 bits of fuel and so forth, because there isn't the
11 capability like there had been in the past at Idaho to
12 examine large spent fuel assemblies. And out team
13 thinks that we can gather a lot of data on separate
14 effects testing.

15 But specifically with EPRI we're starting
16 to gather atmospheric data close to the canister.
17 We're looking at actual surface temperatures. And we
18 want to develop remote optical capability to look
19 inside like a NUHOMS cask. And I think John or
20 somebody will talk more about the Calvert Cliffs work
21 that we're providing funding to work on as well.

22 In the transportation area we've started
23 some criticality analysis to look at for extreme
24 accidents conditions for used fuel and looking at K
25 effective to identify margins under criticality

1 requirements. This was something that was also
2 originally started by NRC and we started to fund it
3 this year. Moderator exclusion is something else
4 we're looking into. So it would provide additional
5 allowance and criticality analysis for damaged fuel.

6 And then the last one, I guess I mentioned
7 it previously, is the transportation testing which is
8 actually obtaining data on realistic loadings that's
9 transmitted to the fuel during transport And this
10 bottom test, picture over here, shows a shaker test
11 that is being designed at Sandia. And we plan to
12 continue this work into FY '13.

13 And someone brought up the Blue Ribbon
14 Commission report and our program had been focused on
15 R&D ever since it just started in 2010, until we're
16 into the third year of it. The Blue Ribbon Commission
17 report came out and, well the draft was last summer
18 and the final. And basically it supported the work
19 that we're doing in R&D, but it had a whole lot of
20 other near-term actions not really related to R&D.
21 And if you follow our budget we actually got a plus up
22 in our budget this past year, in FY '12, the president
23 request \$36 or \$37 million and we ended up getting \$60
24 million.

25 However, the direction wasn't to expand

1 the R&D it was to look into the activities that the
2 BRC has recommended DOE pursue prior to any
3 legislation, or prior to any new, what they call the
4 Fed Corp, or any new organization that would actually
5 take this over. Things like funding regional
6 transportation groups. Developing design concepts for
7 consolidated storage facilities. So these are outside
8 of the R&D area.

9 So anyway, in conclusion. DOE is
10 supporting this research to the extent that we can.
11 We do have funding, to some extent, nothing like what
12 Yucca Mountain program had. Very small bits of it.
13 We're supported by a lab team and we've started to
14 conduct experiments. We're working collaboratively
15 through the ESCP Program with NRC to make sure that
16 our experimental program is really looking at the
17 right things.

18 And we're also working closely with
19 international people. One of our lab members is the
20 chairman of the International Subcommittee under the
21 ESCP Program. So that's what I have to say about our
22 Storage and Transportation R&D Program.

23 CHAIRMAN RYAN: Thank's Jeff, that's a
24 great overview, we appreciate it very much. Any
25 questions for Jeff? Comments? All right, without

1 further ado, John Kessler, you're up.

2 (Off the record comments.)

3 DR. KESSLER: I do have a lot slides, but
4 fear now. Both Chris' of ACRS have admonished me to
5 move along through the slides, so I shall.

6 CHAIRMAN RYAN: You got a little over a
7 minute a slide. They're good.

8 DR. KESSLER: Yes, well, a minute a slide,
9 but you're a chatty bunch. So we're not going to do
10 any better than that.

11 CHAIRMAN RYAN: Well, you still got a
12 minute a slide.

13 DR. KESSLER: Okay. I'll just hit on a
14 couple things based on the questions which you've
15 asked both Jeff and Jim and Bob earlier. I think that
16 just the background, Jim's already talked about, which
17 is that extended storage isn't just a U.S. issue, it's
18 an international issue, and that most nuclear
19 countries now face extended storage, no reprocessing,
20 and now U.S. joins the throngs with no disposal
21 either.

22 And centralized storage, while it may
23 exist, is still storage, and so there's a lot of
24 countries that are out looking for it. There are, and
25 Jim mentioned it again, several countries that there's

1 already work on extended storage under way.

2 Jim mentioned stainless steel dry storage
3 canister degradation, we're going to do some more.
4 NRC has done some nice initial work at the lab scale
5 on dry storage canister degradation to kind of focus
6 in, you know, the wealth of stainless steel
7 degradation knowledge into something that's more
8 relevant, or at least we think might be more relevant,
9 to what's actually out there.

10 There's efforts to continue to take data
11 from that CASTOR V/21 that was in 15 years of storage
12 prior to reopening in about 2000. Japan, Germany,
13 U.S., others -- excuse me, the U.S. and Japan have
14 collected data on that. Bolted casks, Jim mentioned
15 about that, and then the periodic visual inspection of
16 some cask internals, Japan is taking one or two casks,
17 reopening them, I think, every five years, and just
18 doing a visual of them, which provides some
19 information.

20 MEMBER SIEBER: Does that disturb all the
21 conditions?

22 DR. KESSLER: It could. We need to find
23 out about it. I don't know the details about how hot
24 the fuel was or things like that. Nevertheless, even
25 if it disturbs it, it's always good to see what's

1 going on rather than leave it.

2 MEMBER SIEBER: Yes. I would worry about
3 moisture intrusion, all kinds of things --

4 DR. KESSLER: Exactly. I don't know the
5 details of how they do that, so it's a good question
6 to ask and keep in mind; absolutely.

7 MEMBER SIEBER: Okay.

8 DR. KESSLER: So with, primarily, the
9 demise of Yucca Mountain, we recognize that there was
10 a need for international collaboration. A lot of
11 people were doing, more or less, the same thing. The
12 idea is simply to share information as much as we can
13 inside and outside the U.S.

14 Are there common technical issues for
15 future technical work? In a large number of cases,
16 yes there are, and the idea was to identify specific
17 industry needs and regulatory needs for R&D. So two
18 and a half years ago, or so, we launched what we call
19 the extended storage collaboration program, and I
20 think it was Bob Einziger who first dubbed it ESCP.
21 So we now we finally just refer to it as the ESCP
22 program.

23 It's comprised of the people you see there
24 on the view graph. We have quite a few people in the
25 U.S.; vendors, NRC, DOE, utilities, that are all part

1 of it. And you can see the various kinds of
2 organizations across the world that are involved. Our
3 membership keeps growing because of the commonalities
4 of the issues that everybody faces.

5 Here's our mission statement for ESCP.
6 Provide technical bases to ensure continued safe long-
7 term use fuel storage and future transportability.
8 That's what we all agreed to. You know, extended
9 storage is the first part and then, is the fuel
10 transportable after some period of extended storage?

11 It is modeled after that initial work that
12 was done at Idaho.

13 CHAIRMAN RYAN: Sorry, John, just for
14 clarity's sake. This transportable layer, there's two
15 components to that and I'm going to, just for the
16 record --

17 DR. KESSLER: Sure.

18 CHAIRMAN RYAN: -- make sure we're
19 understanding what you mean.

20 DR. KESSLER: Okay.

21 CHAIRMAN RYAN: And I think one is, what
22 shape is the fuel in.

23 DR. KESSLER: That's right.

24 CHAIRMAN RYAN: So clouding, degradation,
25 all those kinds of things come into play, gas,

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1 rupturing, whatnot.

2 DR. KESSLER: Right.

3 CHAIRMAN RYAN: And then the transport
4 unit is, you know, kind of the more standard put it on
5 the road and crash it into stuff or have stuff crash
6 into it.

7 DR. KESSLER: Exactly. Right. The
8 mechanical integrity of the whole system and then
9 there's the mechanical integrity of the fuel.

10 CHAIRMAN RYAN: I just want to make it
11 crystal clear that you're looking at both components,
12 the package and the contents, as a system.

13 DR. KESSLER: Absolutely.

14 CHAIRMAN RYAN: Okay. Thank you.

15 DR. KESSLER: There is a lot of focus on
16 the fuel, but there is increasing focus on the rest of
17 the system and you heard a bit from Jim and Bob on
18 that.

19 CHAIRMAN RYAN: Yes. Okay.

20 DR. KESSLER: Yes. Good clarification.
21 Thank you.

22 DR. KESSLER: Thank you.

23 MEMBER SKILLMAN: For this program, what
24 are the rules for admission and how often do you meet?
25 And who runs it?

1 DR. KESSLER: The rules for admission is,
2 you have to be actively working on, or planning to
3 work on, extended storage issues. If you've got
4 funding, that's something that we want to have you do
5 to be included. In terms of who runs it, EPRI is kind
6 of the coordinator, but in a sense, it's self-run.

7 We provide meeting space and if there is
8 a need to publish something jointly, EPRI volunteers
9 to publish it for people, but it's really self-run in
10 the sense that we have subcommittees. Jeff mentioned
11 we have an international subcommittee that's run by
12 some volunteers. I'll talk about some subcommittees
13 here in a second.

14 But it's basically people who have an
15 interest in a particular area that run, we just try
16 to, you know, facilitate it all happening.

17 MEMBER SKILLMAN: Thank you.

18 DR. KESSLER: Okay. So three phases for
19 the program. Phase one, we're pretty much done, are
20 these gap analyses. What data do we think we need to
21 establish extended storage followed by transportation?
22 Phase two is where we're getting ourselves into, which
23 is conducting the experiments, field studies, and
24 additional analysis to address the gaps. You've heard
25 some from Jim and Bob, as well as Jeff, what's going

1 on.

2 And then phase three is getting into what
3 I'd say are more the field trial stages and the field
4 inspections that we're starting to think about now.
5 I mentioned the subcommittees, here are the six
6 subcommittees we have now. So you can see, we focus
7 on various parts of these storage systems in terms of
8 specific degradation mechanisms, or in one case, the
9 confirmatory demonstration that I'll talk about a bit
10 more.

11 Highest priority items, this is me
12 summarizing from a couple different reports that you
13 heard about earlier. Welded stainless steel
14 canisters, stress corrosion cracking is at the top of,
15 essentially everybody's list. For high burnup
16 cladding, it's the hydride effects, the reorientation
17 and embrittlement.

18 And I would argue that one view graph that
19 Jeff showed isn't atypical of what high burnup fuel
20 may look like; decent amount of hydrides, but still
21 circumferential. The issue is, when you heat it up
22 and apply stress on it, do those circumferential
23 hydrides turn into radial hydrides that really would
24 start decreasing the ductility?

25 So that example was fairly high burnup,

1 but not atypical. Okay. So we're interested in those
2 issues. Bolted casks, you heard, corrosion of bolts,
3 embrittlement, and degradation of the bolts, and then
4 fuel pellet swelling that Jim talked about.

5 MEMBER ARMIJO: Do you have any papers
6 that describe and provide something quantitative on
7 the fuel pellet swelling at those kinds of
8 temperatures as a function of time?

9 DR. KESSLER: EPRI doesn't. There's a lot
10 literature out there that I think even NRC is kind of
11 pulling together. You know, the amount of --

12 MEMBER ARMIJO: Are there any papers, key
13 papers, that you cite in your -- to justify this is a
14 significant issue?

15 DR. KESSLER: That one's an NRC one, so
16 you should ask NRC.

17 MEMBER ARMIJO: I will.

18 DR. KESSLER: I know some of the work that
19 they've cited is a guy named Vincenzo Rondinella at
20 ITU in Germany, who's done a lot of work on how many,
21 you know, alphas you'd expect that would turn into
22 helium gas that causes this internal pressurization.
23 That's just one example of R&D that's been out there.

24 MEMBER ARMIJO: Right. But, you know, as
25 far as a, kind of, systems analysis of --

1 DR. KESSLER: No.

2 MEMBER ARMIJO: -- the pellet and how much
3 helium is there compared to how much helium is in the
4 gap anyway, plus other fission gases. All these other
5 things --

6 DR. KESSLER: We haven't done it, but I
7 think NRC probably has as well as these other
8 organizations, so you'll have to ask them.

9 MEMBER ARMIJO: I'll just ask the staff to
10 get me that because I think we need to understand that
11 because that's what's driving everything. That's
12 where the stress is coming from, unless there's some
13 other source. And if that's a strong case, that's
14 okay, but if it's a weak case, we'd like to understand
15 it.

16 DR. KESSLER: Right. That's, essentially,
17 a different mechanism than, of course, the irradiation
18 hardening ones that effect all kinds of different
19 materials. But, yes, this one where you actually
20 cause, you know, the amount of helium being generated
21 from alpha decay. That's the primary one that NRC and
22 some others are interested in as a potential mechanism
23 that needs more data; that could be important.

24 MR. EINZIGER: Sam, I'll get you some
25 references.

1 MEMBER ARMIJO: Yes. I'd like to read --

2 MR. EINZIGER: It's all unpublished at
3 this time and it's all very weak. It's enough to wet
4 your appetite, but not to feed you.

5 MEMBER ARMIJO: Okay. Thanks, Bob.

6 DR. KESSLER: Well, thank you, Bob.

7 MEMBER ARMIJO: I'll read it. But, you
8 know, that's, to me, a key thing. If you can show
9 that you do have sufficient swelling to drive the
10 stresses and cause hydride reorientation, that's one
11 case, but if you don't have swelling and somebody's
12 really creating a mechanism that might occur at a
13 higher temperature, but just isn't going to do
14 anything at this temperatures, then you ought to take
15 a critical look at that before you launch --

16 DR. KESSLER: Absolutely. And then
17 there's also the question of when the swelling occurs.
18 For example, in this mechanism, the swelling occurs
19 over, Jim mentioned, I think, a 100 years or more, and
20 by that time, temperatures are pretty low, whether
21 that actually causes hydride reorientation or it's
22 just the, you know, increased stresses --

23 MEMBER ARMIJO: Yes. Nothing's mobile.
24 You know, everything is --

25 DR. KESSLER: Well, that may not be the

1 issue in terms of what could fail the cladding then,
2 but again, you'll have to ask NRC later. Cross-
3 cutting needs, again, I've summarized the ones that
4 we've seen --

5 MEMBER ARMIJO: John, since you represent
6 the industry to some extent, the issue of welded
7 stainless steel canister chloride stress corrosion
8 cracking --

9 DR. KESSLER: Right.

10 MEMBER ARMIJO: -- is such an old issue
11 and our canisters are not just one weld, we have a
12 double weld, right?

13 DR. KESSLER: Just for the closure lid.

14 MEMBER ARMIJO: The closure lids, there's
15 a weld underneath the closure lid --

16 DR. KESSLER: Right.

17 MEMBER ARMIJO: -- that'll protect it from
18 the --

19 DR. KESSLER: The body of the canister,
20 though, is a single weld that's not stress relieving.

21 MEMBER ARMIJO: The body, which you're
22 talking about, the axial welds?

23 DR. KESSLER: There is longitudinal welds
24 when you create the cask cylinder. They're rolled
25 from flat plates; 5/8-inch thick 304 or 316.

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1 MEMBER ARMIJO: Okay.

2 DR. KESSLER: So there are longitudinal
3 seam welds, and there are usually four plates so that
4 you have one circumferential weld. Those are --

5 MEMBER ARMIJO: Okay. Those are the welds
6 you're most worried about?

7 DR. KESSLER: Those are the welds we want
8 to look at -- I'll talk about it now. The reason is,
9 it's the outer closure weld, but there's an inner one
10 also that's protected by helium, so it's a fairly
11 inert atmosphere. The out closure weld and the seam
12 welds are the ones that are exposed to the atmosphere
13 and may have some amount of salt deposition from, you
14 know, salt air being drawn in through the air inlets.

15 And that's the part where I hear you. We
16 know a lot about stress corrosion cracking. What we
17 don't know is, do we have the temperatures we think we
18 need? Do we actually have sufficient deposition to
19 drive the reactions the way we need to initiate and go
20 with this?

21 So it's not so much what are the
22 mechanisms, but do the conditions occur? And that's
23 the part that we're trying to get some --

24 MEMBER ARMIJO: You're always going to
25 have uncertainty in a situation like that.

1 DR. KESSLER: Well, given that we have
2 very little data now, we're going to, but the idea is
3 to reduce that uncertainty by going out to the field
4 and getting some.

5 MEMBER ARMIJO: And these canisters were
6 made for Marine Environment Service without any
7 attempt to reduce the residual stresses on the welds
8 exposed to the marine environment; no annealing, no
9 stress relief, no --

10 DR. KESSLER: No annealing, no stress
11 relieving. Those are things that we're about now. I
12 think the idea was is that when these systems were
13 designed originally, the thinking was, these were not
14 canisters that were going to be in service for decades
15 and decades like we're thinking about now. And in
16 addition, it was some mechanisms that I think industry
17 hadn't thought about back when they were being
18 designed; or NRC for that matter.

19 And so now that things are cooling down
20 and we're recognizing what environments they're under,
21 it's becoming more recognized as an issue that we need
22 to address and look into, at least to begin with. So
23 I think that's the history behind, you know, why is it
24 that industry didn't do something regarding, you know,
25 potential stress relieving of the welds?

1 MEMBER SIEBER: Is there suspicion at this
2 point time that some old canisters will have to be
3 discarded and fuel moved to newer packaging?

4 DR. KESSLER: Suspicion? There's a
5 concern that we may have the right set of conditions
6 to support stress corrosion cracking.

7 MEMBER SIEBER: At some locations.

8 DR. KESSLER: Right, at some locations,
9 and hence, the inspection of Calvert Cliffs, followed
10 by a couple more that I'll try to go through here, in
11 terms of what we'd like to do just to put it all
12 together. Do we think we've got the right
13 temperature, and salt, and stress conditions to cause
14 stress corrosion cracking based on the separate
15 effects testing in the lab? What do we actually see
16 out in the field? Do they match up?

17 And then start to get information about
18 what are the temperature distributions? You know, how
19 much salt do we have? To start putting together an
20 industry-wide picture that would feed in, ultimately,
21 to an aging management plan, which is where we want to
22 head with this eventually.

23 MEMBER ARMIJO: Well, how are you going to
24 know what the stress is on these seam welds?

25 DR. KESSLER: Separate tests. One of the

1 things that we're trying to do is get some prototypic
2 welds and go and measure the residual stresses; or
3 calculate them.

4 MEMBER ARMIJO: No, I'm talking about the
5 casks that are actually out in the field.

6 DR. KESSLER: Right. We want to --

7 MEMBER ARMIJO: How are you going to
8 measure the residual --

9 DR. KESSLER: In the field, we're probably
10 not. What we need to do is figure out -- get some
11 samples that were welded under the same conditions.
12 We know what the specs were, we know how many passes
13 were required, you know, what kind of inspections
14 occurred during each pass, so we have some idea of
15 what kind of residual stresses we've got.

16 Okay. Then we can go --

17 MEMBER ARMIJO: Do you know if they were
18 solution heat-treated after the axial welds?

19 DR. KESSLER: I'm not a welding guy. I'm
20 sorry. I can't answer that question. Bob Einziger is
21 back there shaking his head no.

22 MEMBER ARMIJO: The answer is they were
23 not or you don't know?

24 MR. EINZIGER: No, they were not.

25 MEMBER SCHULTZ: And you don't have any

1 archived samples from welds that are --

2 DR. KESSLER: I think there are some, and
3 that's one of the things that we're actually trying to
4 look up now. In fact, Jeff Williams has got some
5 funding; some universities that are looking into this
6 too. So there's a couple of us that are trying to go
7 after just this issue. You know, what are those
8 welds? How are they made? What are the residual
9 stresses?

10 And then we'd like to tie that back to
11 what we're seeing in situ, and then what kind of
12 experiments have been done to say, you know, these are
13 the conditions to support it or not. So we're trying
14 to paint that whole picture.

15 MEMBER SKILLMAN: What will your path
16 forward be if you do this work and determine there
17 really isn't any degradation and there really isn't
18 any stress corrosion cracking of significance? What
19 will you do?

20 DR. KESSLER: I think the idea is, what's
21 an appropriate aging management plan as these systems
22 sit there near the ocean, or wherever they're sitting,
23 for, you know, each additional potential licensing
24 period that the utilities might go into NRC with?

25 So the idea is, okay, can we say that we

1 would expect stress corrosion cracking to be supported
2 when we achieve this set of conditions, okay? That
3 some combination of temperature, residual stress in
4 the welds, salt content on the surface, et cetera.

5 And so then if we can do all the
6 appropriate measurements to say, we know, roughly,
7 when those conditions will all come together we can
8 say, we'll measure all those things externally, and
9 now as we get close to when we think those conditions
10 will support stress corrosion cracking, now we've got
11 to do something more. We've got to go do some kinds
12 of inspections.

13 So the initial work will help us define
14 what's an appropriate aging management plan in terms
15 of what it is we have to go monitor and then when we
16 may have to get more aggressive about inspections.
17 You know, so essentially, we're at step zero or a half
18 in terms of trying to collect the data now; field data
19 I'm talking about. Lots and lots of experimental data
20 and aqueous data, less on atmospheric corrosion and
21 almost none in situ.

22 Okay. I'm going to skip this because I
23 need to get on to the two main field trials. Jeff and
24 Jim both mentioned this. We are grateful for this
25 PNNL that DOE funded to do some thermal modeling of

1 that particular Calvert Cliffs canister. We're going
2 to go measure surface temperatures on the canister,
3 and we'll see if the PNNL models are right, and at
4 least it will provide some benchmarking data.

5 It also helps us determine where we want
6 to take samples, so thanks PNNL, already, for
7 providing that thermal analysis.

8 MEMBER ARMIJO: Is that a best estimate
9 analysis?

10 DR. KESSLER: The PNNL one is. That gets
11 back to one of your questions earlier about -- the
12 industry models tend to overestimate temperatures,
13 which was great for making sure your peak temperatures
14 didn't exceed 400 during drying. But is it the wrong
15 direction for when do these potential conditions
16 supporting stress corrosion cracking, when would those
17 occur?

18 You tend to over-predict. You know, you
19 predict it would happen farther out in time than it
20 might really happen if you had a better estimate
21 model. So best estimate models help on both ends in
22 the sense of getting us a better idea of when things,
23 or to what extent will things, happen.

24 My opinion, the better estimate heat
25 transfer model helps during drying, because it may be

1 that only a small fraction of the cladding, even for
2 high burnup, gets anywhere near 400 C during the
3 drying process if we actually did best estimate
4 calculations. And that'll tie back into this demo
5 program that we're thinking about that I'll try to get
6 to here.

7 Okay. Yes. Various examples of the kinds
8 of testing that's already underway. I'm going to skip
9 this, other than just to point out, there's a lot of
10 work that's already underway, both in the U.S., and
11 especially outside the U.S., on some of these
12 particular mechanisms and components of the system
13 that you've heard about earlier.

14 MEMBER SCHULTZ: John, general question
15 there. Where do the schedules of these separate
16 components converge? In other words, when we look at
17 the modeling in the laboratory testing program that is
18 underway, are we looking at a horizon of two years;
19 one year, two years, three years?

20 DR. KESSLER: Again, it's a question you
21 have to ask each organization. This is what's the
22 benefit of sharing these gap analyses, you know, what
23 data do we need and what are the priorities on getting
24 the data? We have reasonable good consensus on both
25 the gaps and the priorities. I'm kind of dancing

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1 around answering your question because it depends on
2 who's funding it.

3 I know that, for example, BAM in Germany,
4 CRIEPI in Japan, are doing some really nice ongoing
5 work on seals in bolts that I would guess is going to
6 be done in three years or less. There is other work,
7 what are the conditions that support stress corrosion
8 cracking? That's been going on. I expect more data
9 to be done in the lab over the next two or three
10 years.

11 The field inspections, we're planning to
12 do a total of four, maybe, over the next two years and
13 then we'll see what we get, you know? Depending on
14 what we see, maybe four will be nearly enough or maybe
15 we're going to have to inspect a whole lot more.
16 That'll take us quite a few years.

17 The high burnup demo, I'll talk about the
18 schedule for that one, but anywhere from two years to,
19 maybe, five to ten years in terms of time frames when
20 we get some information. And for the full-scale demo,
21 we got to load it, let it cook for about ten years,
22 and then reopen it. To get all those data, you're
23 talking 15 years or more before those data are
24 available.

25 CHAIRMAN RYAN: John, you were doing good,

1 but you're falling behind.

2 DR. KESSLER: Yes, okay. All right.

3 Thank you. Okay. Let's get into field inspections.

4 We talked about stress corrosion cracking. I'm going

5 to skip that. All right. On to what we're doing.

6 Right now, June 28th is the magic date that Calvert

7 Cliffs will be the first one to go in and visually

8 look at the surface of the canisters, specifically for

9 signs of corrosion and stress corrosion cracking.

10 Why did we pick Calvert Cliffs? Well,

11 first and foremost, their license was coming up for

12 renewal and they had to do some inspections to support

13 NRC's requirements for license renewal. They were

14 kind enough to volunteer up a second canister that may

15 be one that's more in the right conditions for stress

16 corrosion cracking, which is, it's old enough, so it's

17 had some time to accumulate salt, if it is

18 accumulating salt.

19 That means it's going to be colder

20 conditions, and again, something that may support

21 stress corrosion cracking. So they're going to do

22 visuals on both and then we're going to do a bit more

23 on the lower temperature canister.

24 MEMBER BLEY: Do you know how they're

25 doing the visuals?

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1 DR. KESSLER: A boroscope camera and I'll
2 show you a cartoon or two of, roughly, where they're
3 going to shoot things through. So I mentioned visual,
4 we're also going to take some surface temperature
5 measurements of the canister, and then we're going to
6 try to get some samples of surface contaminants just
7 to see what we've got; dust, salt, whatever.

8 MEMBER ARMIJO: By visual, what kind of
9 magnifications are you going to use?

10 DR. KESSLER: Oh, goodness. I don't know
11 that number, but I can tell you --

12 MEMBER ARMIJO: If you can see it with the
13 naked eye, you've got big problems.

14 DR. KESSLER: I can tell you that from
15 three feet away, they could see the eyeballs of a
16 black widow spider that was done at one corner of --

17 MEMBER ARMIJO: So they have a
18 magnification capability.

19 DR. KESSLER: They have a pretty good
20 magnification capability. We're hoping, but not
21 promising, they can see pretty far into the crevice.
22 This is a horizontal system that sits on stainless
23 rails. It'd be nice to see into the crevice as much
24 as we can, but primary thing is to take a look at
25 those circumferential and longitudinal welds.

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1 MEMBER ARMIJO: Do you have good
2 fabrication history information on those canisters?

3 DR. KESSLER: Yes.

4 MEMBER ARMIJO: So you know that they
5 weren't made with a pristine press procedures that I
6 would --

7 DR. KESSLER: Exactly. In fact, we have
8 this one, the cold one, we have visuals of what it
9 looked like, because they did some demo work with it
10 initially. So we have photos of what it looked like
11 when it came out of the shop, essentially, and you
12 can't see yourself, like, in a mirror, like some of
13 the other manufacturers.

14 MEMBER ARMIJO: But you know it wasn't
15 post-weld annealed? There was no attempt to polish
16 the welds or anything like that?

17 DR. KESSLER: Not sure, but we do have
18 that information.

19 MEMBER ARMIJO: Okay.

20 DR. KESSLER: I just don't know it, but I
21 know that those data exist. So we know how it was
22 made; we know what the criteria were.

23 MEMBER ARMIJO: The reason I'm pressing on
24 this is that the state of residual stress at the
25 surface of that canister is entirely dependent on the

1 way it was fabricated.

2 DR. KESSLER: We know that.

3 MEMBER ARMIJO: And if you don't have that
4 information --

5 DR. KESSLER: We know that.

6 MEMBER ARMIJO: -- I don't know how far
7 you can take the findings, good or bad --

8 DR. KESSLER: I hear you. It's one of
9 those things that if we can't correlate up the
10 residual stresses, the amount of salt, the humidity,
11 the temperature, all of those things together, then
12 it's going to be hard to develop an aging management
13 plan we can rely on. So absolutely, we need to know
14 what the residual stress distribution are of those
15 welds and that is part of both industry's testing
16 program, and you heard from Jeff, part of what DOE's
17 going to be looking at too.

18 So, yes, that's, you know, in the books to
19 do some work.

20 MEMBER SKILLMAN: It could be that your
21 crumbiest looking cask is the one that has no stress
22 because it hasn't been polished and the welds have not
23 been affected. In fact, the thing may have been
24 crimped in position, the welds nothing more than a
25 cosmetic seal, and there is no stress.

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1 DR. KESSLER: We don't know. We'll find
2 out, at least on some of them. And then we are
3 thinking about, in the longer run, can we measure, in
4 situ, residual stresses, but that's down the road,
5 because that's a little harder to develop.

6 Okay. Back to this picture that's similar
7 to the one that Jeff showed. I actually like Jeff's
8 better because he showed one of the analyses of that
9 PNNL work. So this is kind of a see-through view of
10 this Calvert Cliffs new homes, the new tech horizontal
11 module system. You can see the canister laying in
12 there sideways. You get kind of a cartoon of the
13 longitudinal welds and the seam welds.

14 The closure weld is, I think, at the far
15 end. What's important, this is natural convection, so
16 you see the air inlet in the bottom left coming in
17 underneath, and the two air outlets at the top. For
18 visuals, the plan is to put this boroscope,
19 essentially, on a glorified stick, bring it in through
20 the air outlets, and see what they can see.

21 Apparently they can see a good chunk of
22 the canister's surface just by going through the air
23 outlets. I mean, the surface dose rates on the
24 canister surface are in the 1000 to 10,000 R an hour.
25 So that means you got to do things pretty remotely and

1 that limits what we can do.

2 Then I think I may have it in the next
3 one. Yes. Good. That's for the visuals. For the
4 surface temperatures and the salt samples, we're
5 actually going to go through a 3/4-inch gap between
6 the entrance to the module and the outside of the
7 canister, and slide a tool, and place those Salt
8 Smarts that Jeff had in one of his pictures, along
9 with a thermal couples at various angular locations
10 and locations along the length of the canister.

11 And start getting the information on the
12 distribution of how much salt we see and the
13 temperatures to start putting some of these pictures
14 together in terms of everything that we need to assess
15 whether we should or shouldn't have stress corrosion
16 cracking, and that, of course, goes with the visuals.

17 There's a picture of the Salt Smart again.
18 We have a backup system we may use where, essentially,
19 we're taking a scratch pad with a vacuum cleaner to
20 try to pull up the dust too as a backup for the Salt
21 Smart system, and we'll see how much of it we get to
22 because the rad protection folks at the site are being
23 real sticklers on how much dose we're allowed to get
24 for this research activity on top of the other things
25 that are going on.

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1 CHAIRMAN RYAN: How much are we allowed to
2 get?

3 DR. KESSLER: 75 to 100 person millirem.

4 CHAIRMAN RYAN: For?

5 DR. KESSLER: For the whole inspection.
6 So we're having to make sure we get our guys in there,
7 put it on there, and get out of the way. We've gone
8 through dry runs two weeks ago to try to get the
9 technique down to minimize their exposure.

10 CHAIRMAN RYAN: Okay.

11 DR. KESSLER: But that will limit, you
12 know, how many data points we can collect when we hit
13 that limit. Okay. On top of all of that, if we'd
14 like to do a correlation to how much salt we see on
15 the canister versus how much salt is in the atmosphere
16 and how long it's been sitting there, we need to
17 figure out how much salt there is in the atmosphere.

18 MEMBER BLEY: You going to do this over
19 some extended period of time?

20 DR. KESSLER: Oh, yes. At least a year.

21 MEMBER BLEY: Okay.

22 DR. KESSLER: To get some sort of annual
23 average salt concentration that we can then correlate
24 back to the canister surface.

25 CHAIRMAN RYAN: Are you happy with a year

1 being enough data?

2 DR. KESSLER: I'll take what I can get.
3 We have some data that's already archived at Calvert.
4 Some sites do it; some sites don't. We'll do what we
5 can.

6 CHAIRMAN RYAN: Are you going to try to
7 pool data or do the best you can --

8 DR. KESSLER: Right. We've already put
9 some data out that's been collected, like, by NOAA and
10 other folks. It's not right at the site, but we'll
11 cobble stuff together and run, you know, these kinds
12 of in situ devices for as long as we can with the
13 money we've got.

14 MEMBER BLEY: I guess, with Mike's
15 question, you know, when a hurricane comes close to
16 one of these guys, you get a lot of salting up of lots
17 of equipment, which means you must get a lot of salt
18 deposition around these. And without a major storm
19 like that, that's a big gap, I think, in the
20 information.

21 DR. KESSLER: It's a good point. Clearly,
22 if it's the once every ten years storm that provides
23 the majority of the salt, we're going to miss it if
24 that's the case. I think we probably have enough idea
25 -- we have to bear that in mind.

1 MEMBER BLEY: Yes. I suspect you can get
2 information on that kind of storm from some other
3 place.

4 DR. KESSLER: Well, and then we can also
5 go and see how people calculated averages, temporal
6 averages, anyway and how much these affect things.
7 That's literature mining we have yet to do, but it's
8 a very good point.

9 Okay. I mentioned the inspection
10 schedule. They're going to do the visuals on June
11 27th, weather permitting, and then the temperature and
12 salt measurements on the 28th, and then the
13 environmental monitoring will get going at a later
14 time.

15 I mentioned we're going to try to find
16 some more volunteer to do some of these inspections.
17 There's the criteria. Right now, we have seven
18 utilities that have expressed interest, I think five
19 of them have sites on or near the coast, so I think
20 we've got some people to talk to lined up to do the
21 additional inspections.

22 We have some inland sites if we need them.
23 So in terms of volunteers, they're getting lined up
24 for additional inspections. And as Jeff mentioned,
25 for the ones past the Calvert one, DOE will be

1 providing co-funding to do some of these inspections,
2 so that's great.

3 Okay. Next subject, on from inspections
4 on to this confirmatory demo. The idea of, can we
5 open something up and look at what's going on inside?

6 And the idea is, take some sort of full-
7 scale cask, load it with higher burnup fuel,
8 instrument, a lid that you're going to put on this
9 thing for, say, temperature and gas analyses, take
10 those temperature, and take gas samples from time to
11 time during the drying process and during this, say,
12 ten-ish years after that, and then move the cask
13 somewhere, take the lid off, pull some rods out, maybe
14 some assemblies out, and see how much they've changed.

15 And then take a look at, maybe, not just
16 the cladding, but the spacer grids, as was talked
17 about earlier, take a look at, you know, has there
18 been degradation of any other cask internals. So
19 that's the idea of what's going on in terms of what
20 we'd like to do.

21 All of that is to confirm, in a sense, the
22 separate effects testing there that you heard Jeff and
23 Jim both talk about. They'll have the laboratory
24 scale or the sub-full-scale kind of testing that you
25 use to generate the majority of you data, we need to

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1 have a couple of these confirmatory demos to say that
2 those test conditions are the right ones, like Bob was
3 talking about earlier.

4 And so in our view, a full-scale
5 confirmatory test is going to be needed over some time
6 period. So we're looking for, you know, higher burnup
7 systems, things like that. We're looking for
8 volunteers. So here's the objectives. One of the big
9 issues is right here, avoid re-wetting the fuel after
10 initial loading.

11 This is that issue about if you open and
12 close it, is that going to mess up the properties of
13 the cladding? That is a concern and DOE is proposing
14 to do some work to assess what impact of, say, instead
15 of being able to open the lid in dry conditions so
16 that there's not the thermal shock, maybe you have to
17 bring it back into a pool.

18 All right, how is that going to affect
19 what you see for cladding properties, and then, if you
20 have to re-dry it and put it out there for another ten
21 years, how much loss of information based on true
22 prototypic conditions do you get? That's a thing we
23 have to work through.

24 Right now, the goal would be, with
25 everything dry, but we don't have a facility in the

1 U.S. that can handle a full-scale cask in dry
2 conditions to take the lid off. That's going to be
3 something that will have to be constructed either at
4 a national lab or who knows, maybe at some
5 consolidated storage facility some time down the road.
6 It will be part of the facilities there.

7 Okay. For this demo, there's quite a few
8 steps. Before we get this thing going, we need to
9 have initial data, which is, what's the condition of
10 the cladding at T=0, before you get things going? And
11 I show the T=0 data for the rods.

12 Profilometry, the cladding properties,
13 which I have listed there, then we've got to modify
14 that existing cask to put a special lid that includes
15 the thermal couples and the gas samplings, load the
16 cask, and then place the lid.

17 And even before we've let it cook for ten
18 years, we're going to get good temperature data that
19 we don't have now and we're going to get gas sample
20 data for krypton-85 to see if we've got leaks that are
21 occurring during storage. Oxygen, do we have oxygen
22 in there? Water, it's that question earlier about how
23 adequately are the casks dried?

24 We can measure how much humidity there is
25 in the air and get an idea of how much water there is.

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1 So all those data will be coming during that storage
2 period. And then after so many years, we'll open,
3 remove some rods, we'll visually inspect them, and
4 then compare them to the T=0 data, and we may look at
5 some of the other cask internals.

6 MEMBER ARMIJO: John, could you go back to
7 that chart?

8 DR. KESSLER: Ooh, geez. Can I go
9 previous? Ooh, look at me.

10 MEMBER ARMIJO: Yes.

11 DR. KESSLER: Okay.

12 MEMBER ARMIJO: To get the hydrogen
13 content initial hydride orientation --

14 DR. KESSLER: Yes.

15 MEMBER ARMIJO: -- you actually will take
16 out some fuel and do some destructive examination?

17 DR. KESSLER: Yes.

18 MEMBER ARMIJO: Okay.

19 DR. KESSLER: Yes, from sister rods or
20 maybe even from the same assembly. We may pull a rod
21 or two out of the actual assembly that will go into
22 the demonstration cask. And then perform destructive
23 exams on those claddings, yes. So, yes, that's the
24 idea, or we'll find some other assemblies that have
25 the same irradiation history, you know, from some

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1 other, you know --

2 MEMBER ARMIJO: And you will purposely
3 select high burnup fuel that probably has a high gas
4 release or, you know, we have this variable of the
5 cladding material --

6 DR. KESSLER: Exactly.

7 MEMBER ARMIJO: -- and how much hydrogen
8 pick up there is, whether it's Zirc-4; insert that.

9 DR. KESSLER: Yes. And one of the reasons
10 why we like a particular demo, which is one that
11 Transnuclear and Dominion are proposing, is that it
12 would happen at North Anna, where Dominion is
13 volunteering to start this demo at North Anna. They
14 have M5, Zircaloy, and Zirc-4 all in the 50-plus
15 gigawatt day per metric ton burnups.

16 So they've got three different kinds of
17 fuel, admittedly, it's all PWR fuel, but three
18 different kinds is probably about as good as we're
19 going to get at any individual site. So we've got TN
20 who's willing, probably, to reduce costs to provide
21 two casks as part of this.

22 And what's nice about it, given that it
23 can be started at North Anna rather than waiting for
24 one of these dry handling facilities, it can probably
25 be started in, maybe, three to five years. And where

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1 we're at now is, EPRI is just about to initiate
2 funding for TN with Dominion's help to start designing
3 what this lid should be.

4 We're going to work with DOE and others in
5 terms of what kind of testing should go on? We'll
6 certainly involve NRC in terms of what kind of tests
7 should we do? Where are these thermocouples going to
8 be located; et cetera?

9 And then we're going to be looking for co-
10 funding, and right now we're talking to DOE, but, you
11 know, between EPRI, and D-TN, and Dominion, and maybe
12 DOE, we're hoping to pull together the funding to get
13 this demonstration going, say, in the next three to
14 five years.

15 Ooh, only a couple minutes over. Sorry.

16 CHAIRMAN RYAN: You're going good, John.
17 Any questions for John; additional questions?

18 MEMBER SIEBER: Is there an opportunity
19 for you to discover that as a cask deteriorates, that
20 fuel inside is deteriorating at even a faster rate, so
21 repackaging becomes a very difficult situation?

22 DR. KESSLER: It would happen through the
23 demo program where we would see what happens with the
24 cladding. Some of the separate effects testing, we
25 would get an idea of how rapidly the assemblies might

1 degrade in the presence of, say, water, or oxygen, or
2 something like that, so there are opportunities.

3 MEMBER SIEBER: I think it's important to
4 keep in mind that the packaging may deteriorate at a
5 rate slower than the fuel inside, depending on the
6 conditions that it's in. And from a safety and
7 economic standpoint, it'd be good to know that.

8 DR. KESSLER: Yes. Good point.

9 CHAIRMAN RYAN: Any other questions for
10 John? Stephen? Anybody else? John, thanks very
11 much. It was a great briefing.

12 DR. KESSLER: Okay.

13 CHAIRMAN RYAN: All right. Next up, Rod,
14 your turn. Fire away.

15 MR. MCCULLUM: Yes, I want to thank the
16 committee for the opportunity to speak here today and
17 I will try to address some of the regulatory
18 perspectives from the industry viewpoint that on this
19 issue, much has already been said about the R&D.

20 I do want to say, in addition to thanking
21 the committee for the opportunity for me to speak, I
22 thank the committee for looking at this subject.
23 Extended storage is a reality. I know Jeff says I
24 tend to blame him for, you know, the conditions, but
25 the fact of the matter is is that, the Department of

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1 Energy has made policy decisions which mean that we
2 will be storing used fuel for an extended period of
3 time, whether it's at consolidated sites or existing
4 reactor sites.

5 You know, as we address this challenge and
6 try to figure out what it means for the regulator and
7 the regulated, we need to do so in a stable,
8 disciplined, and risk informed manner. This
9 subcommittee, and its expertise, and its independent
10 views will be, I think, very valuable towards helping
11 shape that going forward.

12 And certainly, from what I've heard this
13 afternoon, you have not disappointed me in that
14 regard. You are all asking the right questions and I
15 would encourage continued focus on this. To start out
16 here, this is a slide that kind of gives some more
17 data behind something I think that Jim already
18 mentioned earlier this afternoon, that we have 1500
19 casks out there; anticipated to double that number by
20 2020.

21 This is really -- and it's in a lot of
22 different locations, obviously. The point of showing
23 this here, and it's useful to keep in mind as I go
24 through the regulatory perspective, it talks about the
25 scope of the challenge before us and I think it says

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1 two things.

2 First of all, obviously, it says that dry
3 cask storage is probably the most recession-proof
4 business in the country. And the second thing is, we
5 have a lot of experience with dry cask storage. Some
6 of these casks have been out there for more than 20
7 years. There's a couple places where we've been
8 through our first renewal already.

9 They are successfully performing their
10 safety function. You know, as we look at some of
11 these degradation mechanisms that we've been talking
12 about here and trying to prioritize where the needs
13 are, it's not that we expect things to be going wrong
14 on some time period, but it's that we need to conduct
15 a focused research so that we can further confirm the
16 confidence that our experience has given us, as well
17 as extend that confidence out over greater periods of
18 time.

19 To put a slightly finer point on that
20 graph, I've broken some of these numbers down. I
21 apologize for the grey area on the right-hand side of
22 the chart. That simply means that NEI wasn't
23 gathering data at that level of granularity over those
24 years. But the point of this slide is, as you can
25 see, we only had two ISFSIs for a while, for the first

1 three years, back in the 1980s, and very gradually
2 added ISFSIs.

3 And you can kind of extrapolate to the
4 number of casks. It somewhat follows the number of
5 ISFSIs. So that we have the opportunity to learn from
6 our experience at a very few sites before we have to
7 address the challenge, you know, on a very large
8 industry-wide basis.

9 And I think some of the things that we've
10 talked about already from the cask that was opened at
11 Idaho, to the demo project we're setting up now at one
12 of those first two ISFSIs that was licensed, will help
13 us do that. And I think Bob Einziger said it best, we
14 want to stay ahead of the curve. This is the curve we
15 need to stay ahead of.

16 Again, we've got a strong basis and
17 confidence in safety, it's about confirming that. You
18 know, and I really appreciate some of the questions I
19 heard to day, you know, do you really expect this to
20 happen? Well, no, we don't, but we're going to go
21 chase these degradation mechanisms anyway so that we
22 can run it all to the ground and further verify that.

23 In summary, on the basis for safety,
24 there's a lot of things out there. Again, these are
25 very robust systems with no moving parts. You know,

1 stepping out, you know, it's been mentioned in the
2 marine environment, there's a lot of things in marine
3 environment. We have a lot of, you know, experience
4 outside just dry casks.

5 We have all kinds of structures and
6 systems that exist under all kinds of conditions.
7 Maybe not the exact same conditions that we are
8 looking at here, which is why we're doing the demo and
9 the other inspection work, but we have a lot of
10 confidence that systems way less robust than this, in
11 challenging environments, can last for extremely long
12 periods of time.

13 So given the very nature of what these
14 things are, the confidence starts there. That and,
15 you know, I won't try to go backwards here, but when
16 we were renewing those first two licenses, we did get
17 a lot of information and those licensees had to make
18 the case to the NRC, and did successfully make the
19 case that an extension of the license to go from 20
20 years to now 60 years, because originally, it was, you
21 know, you had 20-year terms, you get a 20-year license
22 with 20-year renewals.

23 Now, NRC has amended the regulation, based
24 on what it learned from those first renewals, to allow
25 40-year terms. And the question was asked earlier, I

1 want to come back to, you know, what is extended
2 storage? You know, and I think Jim put a really good
3 point on it, he says, we're talking about the second
4 renewal here.

5 You know, we have a strong basis for the
6 first renewal, so some casks got a 20-year term and
7 are going to get a 40, some will start with a 40 and
8 get another 40, so basically, extended storage begins
9 somewhere between 60 to 80 years, depending on what
10 cask you're in.

11 So again, you look at that curve of the
12 rate at which extended storage is coming on to us --

13 CHAIRMAN RYAN: I take from that kind of
14 numerical example, I think that, beyond 80, 40 and 40,
15 is there something going to be new out there, or do
16 you feel if you get 40 plus 40 we're really kind of
17 closing off the need to get further research, or see
18 how things behave over longer periods of time than
19 that?

20 MR. MCCULLUM: I personally don't expect
21 much or anything new at all. I think what is is, we
22 want to have data, again, staying ahead of the curve.
23 We want to have leading data, so that when we get to
24 that point, you know, the regulatory process is, it
25 should be very rigorous and it's not based on, you

1 know, elicitations of opinions, it's based on data.
2 It's based on what we know.

3 And so while we have time to contemplate
4 extended storage, industry is moving with a great
5 sense of urgency on some of these programs. And we're
6 moving, as I'll talk about in a minute, some great
7 expectation for DOE to help us fund those programs.

8 The waste confidence rulemaking examined,
9 again, the large population of information that is
10 already known, concluded that studies perform to date
11 have not identified any major issues with the long-
12 term use of dry storage. Probably one of the most
13 important data points I have is, the EPRI and NRC dry
14 cask storage PRAs from 2007.

15 Those showed an annual cancer risk of
16 between 1.8 times 10 to the minus 12th and 3.2 times
17 10 to the minus 14th, that's against a standard in
18 NRC's risk informed decision making criteria of 10 to
19 the minus 5, 10 to the minus 6 worker's public. That
20 tells me there's a lot of safety margin here.

21 So we're starting with very robust
22 systems. We've got a lot of safety margin. We have
23 a basis of experience. We have other things out there
24 we can compare them to and now we're doing focused
25 research on those very systems. The mantra for the

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1 demo project, real data on real fuel in real casks.

2 Certainly believe DOE should, within the
3 next 10 to 15 years, develop the capability to open
4 casks in a dry environment, whether it be at a
5 consolidated storage facility or at one of its
6 existing labs, and that almost becomes a political
7 question, not a technical question.

8 So within these parameters we have the
9 opportunity, and as I say, industry is very
10 aggressively pursuing these opportunities.

11 CHAIRMAN RYAN: Just a little extra point
12 there for the members benefit. The cancer rate in the
13 United States right now is between 0.2 and 0.3.

14 MEMBER SCHULTZ: But admittedly, the
15 studies done in 2007 weren't focused on extended
16 storage. They were focused --

17 MR. MCCULLUM: No, they weren't on
18 storage.

19 CHAIRMAN RYAN: No, I'm just pointing out
20 there's 14 orders of magnitude between actual cancer
21 rates and what they calculated.

22 MR. MCCULLUM: But it tells us that we can
23 tolerate a certain amount of degradation before -- you
24 know, there's some safety margin out there and we
25 haven't seen degradation, you know, the doses at the

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1 site boundary due to dry cask storage in 1500 cases
2 are zero, you know, over quite a few years.

3 So I'm not trying to take credit for that
4 same level of risk 80 years in the future. I'm just
5 saying we've got a long way to go from that level of
6 risk to a level of risk that is something we really
7 need to be frightened of.

8 And so, again, that's why I encourage,
9 let's look at this in a risk-informed and disciplined
10 manner. And focus on what we know as well as what we
11 are trying to confirm. This, basically, has been
12 talked about, and I went back a few weeks ago and
13 actually looked at the report from the INL project.
14 We got a lot of data out of that.

15 And we didn't plan that data in advance.
16 It was kind of done on the, okay, well, let's open up
17 an old cask that had been out there 15 years. And we
18 did a lot of examination of the fuel that was in
19 there. Yes, it was low burnup fuel. Now we have the
20 opportunity to do that on a preplanned basis.

21 So the demo project that we're doing,
22 hopefully, at Dominion and TN with DOE's funding help,
23 although industry is putting some money into this, you
24 know, we're going to choose a challenging population
25 of high burnup fuel, we're going to be able to get

1 data real time and not have to wait 15 years for the
2 data because we're going to have an instrumented lid,
3 as John said, so this is going to be, I would say,
4 orders of magnitude, a better demo than the one we
5 had.

6 And the one we had has gone a long way to
7 informing license renewals up to this point in time.
8 And I think we'll certainly have that data and this is
9 why we're treating it urgently. I mean, this is
10 something that's been discussed at very high levels of
11 industry; the need to stay ahead of the curve here
12 before we get to those second renewals.

13 And also, to give confidence behind the
14 licenses that are in place and give us opportunities,
15 you know, to adjust aging management plans and put in
16 place the contingency planning. One of the things
17 that John did not talk about is EPRI is also working
18 on a communications plan for, what do you do if some
19 of these canister inspections actually find something,
20 you know?

21 Going back to all the reasons why we know
22 these things are safe, we have the opportunity, you
23 know, if you identify some stress corrosion cracking
24 on a canister, that doesn't mean the canister fails
25 tomorrow, but that does mean, tomorrow, you start

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1 identifying what you're going to do about it.

2 And so we fully intend to take advantage
3 of that opportunity. And one think I will also
4 mention with respect to DOE's role in this, and I
5 don't want to blame it all on Jeff, but we believe
6 that the Blue Ribbon Commission report did
7 specifically identify this area. It did talk about
8 the need for research on extended storage in a couple
9 different places in the report.

10 And the \$60 million that DOE has to look
11 at Blue Ribbon Commission stuff, some of it, very well
12 in accordance with that report, should go there and
13 I'm happy to report it looks like some of it is going
14 to go there. We've had some very positive dialog with
15 DOE, they are going to be participating in this demo,
16 they understand why it's important to industry, and,
17 you know, we look forward to more strong
18 participation.

19 DOE has made decisions to redesign the
20 Federal/Civilian Radioactive Waste Management Program
21 in ways that will cause extended storage to be a much
22 bigger part of that. With that comes the obligation
23 for DOE to fund the work, which will continue to
24 support the licensing of those extended storage
25 systems over those periods of time.

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1 And so far, the early returns are, they
2 are beginning to warm to that task. I want to change
3 gears just a little bit here, although it is something
4 that has been raised in the context of extended
5 storage.

6 You know, an effective regulatory process,
7 above all, it must assure safety. It needs to focus
8 on the more significant risk and not get distracted by
9 the least significant risk; be risk informed. We need
10 to recognize dry cask storage as a mature industry,
11 benefit from all that we've done with 1500 casks, be
12 consistent with good principles of regulation, and
13 those include things like efficiency, and clarity, and
14 reliability, and be implemented in a stable manner.

15 So as we're looking at extended storage,
16 the challenge of what the regulations have to consider
17 grows, it is necessary for the regulations to become
18 more efficient. And in all honestly, I'll point out,
19 industry's desire to make dry cask storage more
20 efficient doesn't stem directly from extended storage.
21 It stems from a desire that, as the industry becomes
22 busier and we're loading more and more casks, doubling
23 the population casks, we've got to get more efficient
24 in the process.

25 We believe that the level of detail at

1 which licenses exist today needs to be improved. But
2 this was recognized by COMSECY-10-07 in the context of
3 extended storage, which also tasks the NRC staff to
4 look at improvements in the near-term efficiency in
5 the same vein that the commission was approving going
6 forward looking at extended storage.

7 And more recently, NRC's risk management
8 task force recommended selected guidance and rule
9 changes to make the regulatory framework more risk
10 informed. We heartedly endorse that report and those
11 recommendations.

12 And while our motives for trying to make
13 the regulatory framework more efficient don't directly
14 stem from extended storage, the presence and reality
15 of extended storage makes the need for the regulatory
16 framework to be more efficient, much more pressing so
17 that it can deal with the challenges that are being
18 raised. Yes.

19 MEMBER RAY: You speak of the industry,
20 rightly, as if it were an ongoing vigorous enterprise,
21 but there are a number of parts of the industry, of
22 course, that are legacy nuclear plant operators that
23 no longer are as engaged as others are in the
24 regulatory process or anything else.

25 Now, they still have to be licensed and so

1 on, are they involved in this process?

2 MR. MCCULLUM: Absolutely.

3 MEMBER RAY: Portland General Electric,
4 SMUD, people like that?

5 MR. MCCULLUM: Yes, the Yankees, you know,
6 each year we host our annual used fuel management
7 conference where we bring together the whole industry.
8 We have, as a whole special session, half a day
9 almost, where the decommissioned plants come together.

10 We have a number of task forces on
11 extended storage and other issues. The decommissioned
12 plants are very frequent participants in those task
13 forces. They are as concerned about the issue of
14 extended storage as anybody right now because it has
15 a dual-meaning for them. There's the obvious
16 regulatory implications, there's also the public
17 perception aspect.

18 They do not want the consideration of
19 extended storage to be viewed in their communities as
20 a commitment to extended storage. In other words, if
21 NRC is considering 300 years of storage, they don't
22 want that to be viewed as the government has decided
23 that there will be 300 years of storage.

24 And that's why I think the Blue Ribbon
25 Commission recommended prioritizing moving used fuel

1 off those shutdown sites. That's why consolidated
2 storage is such a -- I mean, of all the things that
3 aren't happening with respect to the Blue Ribbon
4 Commission, consolidated storage is happening.

5 There's a lot of interest in that, you've
6 seen the language in the Senate appropriations bill
7 that's been talked about earlier, the interest in
8 communities in places like New Mexico, although I will
9 say New Mexico is not the only one, is extremely
10 strong.

11 I know Jeff is doing some work on planning
12 for consolidated storage facilities, but all of that
13 means is that, we will have to deal with
14 transportation and a fuel that's been in storage for
15 a while. At the shutdown sites, it's been in storage
16 for a while, and then storing it again at another
17 site.

18 So that continues to support the need for
19 focus programs in this area because the extended
20 storage will continue to occur, it just won't occur at
21 the same sites.

22 MEMBER RAY: Well, the issue of legacy
23 liability for these kinds of operations is a real
24 problem and nothing we can solve easily.

25 MR. MCCULLUM: Right.

1 MEMBER RAY: But if you're imagining
2 yourself out 50 years with a liability that requires
3 you to transfer casks that somebody filled 50 years
4 ago into new casks, you know, you're talking about
5 humongous impacts on --

6 MR. MCCULLUM: Yes, and the goal is --

7 MEMBER RAY: -- companies that don't have
8 any revenue stream to match up with it, but that's a
9 small issue.

10 MR. MCCULLUM: No, the goal is to avoid
11 that. Obviously, the companies that I say are very
12 engaged with our industry-wide efforts and one of
13 those efforts that's at the head of the class is
14 focusing on making sure that consolidated storage
15 happens because DOE takes title when they move it, and
16 these efforts do support consolidated storage.

17 MEMBER RAY: Well, we tried with NFS for
18 a while. Got one in Utah, but just can't get access
19 to it.

20 MR. MCCULLUM: Yes, well, it's the same
21 political problems and, you know, I'm often reminded
22 at NEI how I don't understand politics because it's
23 always so much simpler to me than it seems to play
24 out.

25 MEMBER RAY: And such a mess.

1 MR. MCCULLUM: But anyway, so right now,
2 industry is in the process and we're in the final
3 stages of developing what we hope to be submitting
4 this year, which, as we go through our various
5 industry consensus building processes, will be a
6 petition for rulemaking to improve the efficiency.

7 And if the subject weren't extended
8 storage I'd talk a lot more about why we want to make
9 the regulation more efficient, but we want to
10 standardize the format and content of COCs and tech
11 specs, provide backfit protection. Basically, we want
12 to do to dry cask storage regulation what happened in
13 Part 50 with the standardization of tech specs there.

14 That gained a lot of efficiency, we want
15 to gain the same efficiency. We think the efficiency
16 will benefit the incorporation of extended storage.
17 We've decided not to pursue changes to the amendment
18 process itself. We think by standardizing, getting
19 the level of detail right in the license, there'll be
20 less license amendments going forward.

21 That's the efficiency we're looking for
22 rather than try to make the process of reviewing too
23 many license amendments more efficient. Again, that's
24 kind of off-topic, but I bring it up here because it
25 does help in our extended storage efforts.

1 Some things more specific to extended
2 storage that, while they won't be part of what
3 industry will be seeking to do this year with the
4 staff in terms of that potential petition for
5 rulemaking, things that we think warrant
6 consideration, and they've already been mentioned
7 here.

8 Retrievability, we talked about, you know,
9 the extent to which you care about the condition of
10 the cladding 80, 100, 200 years down the road, depends
11 on the extent to which the fuel is required to be
12 retrievable.

13 And currently, we have requirements for
14 retrievability in the regulation, and I'll have some
15 slides a little bit later talking about a developing
16 view in industry that perhaps the canisters should be
17 the waste form for ultimate disposal, which would
18 lessen the need for retrievability.

19 Obviously, some canisters would want to go
20 to a reprocessing facility, perhaps, and there might
21 be a different standard for if you're loading
22 something you think you're going to reprocess versus
23 loading something that you think you're going to
24 direct dispose of, but that's a long way in the
25 future.

1 The point here is that, and this is where
2 the DOE role is very big, because as DOE designs the
3 next repository system thinking about, what is the
4 role of retrievability and how does that play into the
5 regulatory requirements for extended storage?

6 Moderator exclusion is another one. You
7 know, if you had additional ability to assume water
8 did not get in the package in the analysis. Perhaps,
9 again, then, you know, the condition of the fuel
10 inside the package might be less important and also,
11 in the vein of the good questions that I've heard
12 asked all afternoon here, the harmony between
13 regulations has been raised, and that's something
14 we're looking at is, the system has to work, and I'll
15 talk about systems.

16 You know, you've got Part 71, Part 72,
17 Part 50, you've got the transportation rules that
18 aren't even in 10-CFR, so on down the road, industry
19 may be looking to drive improvements in this area. As
20 I alluded to, taking a systems view of this, and I
21 think that's also been discussed here this afternoon.

22 As a minimum, you have to connect the
23 following elements and the reason I say at a minimum
24 and have an asterisk is, recycling is something that
25 may also happen, but again, you know, I don't think

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1 you're going to go back and recycle all 65,000 metric
2 tons that have been stored to date. You know, a
3 robust recycling system might eventually get to the
4 point where it can keep up with the new arisings.

5 So at a minimum, you're going to have to
6 look at storage reactor sites, transportation, storage
7 at consolidated sites, transportation again, perhaps,
8 unless you, you know, if you store in New Mexico and
9 dispose of at WIPP, I don't know if that's a second
10 round of transportation or not, and then, of course,
11 disposal.

12 And the most important thing is that you
13 have to build this integrated system on the system we
14 have not the one we wish we had. You know, we could
15 unload and reload 1500 casks, because as we mentioned,
16 you know, that's just a question of, you know, what
17 you have to go through to do it.

18 Is that really a smart thing to do? Is
19 that, you know, when you look at, I think, the next
20 slide, well, the answer is no, and I'll get to that in
21 a second. We do want to facilitate direct disposal if
22 possible. That would simplify some of the challenges
23 of extended storage.

24 It's been looked at before. In the 1990s
25 there was the multi-purpose canister system. They got

1 pretty far down the line of designing something that
2 could be disposed of in Yucca Mountain. And because
3 there was a lot of uncertainty at that time as to what
4 Yucca Mountain was going to be designed as itself,
5 that ran aground in about 1997.

6 With Jeff's help, well, he was involved in
7 both efforts, but we picked that charge up again in
8 2005 when we had a Yucca Mountain design that was
9 pretty much locked down at that point. We developed
10 a performance specification and actually had license
11 applications for a disposable canister to be loaded
12 when Yucca Mountain was terminated and the staff no
13 longer had resources to review those applications.

14 Of course, none of the 1500 casks are TADs
15 or MPCs. Realizing that, and this is where the
16 discussion earlier when Jeff mentioned the
17 disposability of existing casks and I said we were on
18 record differing with that, we filed three contentions
19 in the Yucca Mountain licensing proceeding that were
20 built on work that EPRI had done, documenting our
21 belief that the existing dual-purpose systems could be
22 direct disposed of in Yucca Mountain.

23 Now, if the repository isn't Yucca
24 Mountain, will this be challenging? Absolutely it
25 will be challenging. Jeff alluded to some of that,

1 but this is, I think, a challenge worth considering,
2 again, when you think about, do I really want to
3 analyze how cladding looks 300 years from now, or do
4 I want to design a system based on the system I have
5 where it's not as much of a concern?

6 Obviously, you have to know something
7 because there is defense-in-depth to think about, but
8 to the extent that you can place the fate of extended
9 storage on the canister and reduce the importance of
10 retrievability, you do get a benefit. And here's the
11 slide I started to jump into earlier.

12 You know, these are the benefits of
13 directly disposing. You know, radiation exposure
14 ALARA. When you look at the low risks of, you know,
15 a canister degrading and releasing radiation versus
16 the certain exposures you get unloading them all and
17 reloading them all, that's not a very fair risk
18 tradeoff.

19 Obviously, unnecessary costs, we do care
20 about that in industry. One of the things that
21 doesn't get a lot of consideration now, but is very
22 important, because the purpose of these nuclear plants
23 is to generate electricity and a plentiful supply of
24 electricity is, itself, a very important, you know,
25 public health and safety benefit.

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1 We all depend on electricity to live our
2 lives. You start interfering with plant operations if
3 you're bringing casks into pools. The refueling
4 floor, the time is pretty much booked up and we're
5 lucky to get the loading campaigns we now do blocked
6 off on those refueling floors, to have to then start
7 having casks going both ways, that would start to
8 disrupt plant operations.

9 And if you had to reload, now you have a
10 whole other population of low-level waste in those
11 canisters you just unloaded, some you might reuse, but
12 you would have some low-level waste burden there just
13 from the reloading operations.

14 Overall risk reduction, you know, the
15 risks are low, but, you know, you are handling fuel,
16 you are doing things that have industrial safety
17 implications when you move these big casks around.
18 And as I already mentioned, you alleviate the need to
19 assure retrievability for 80, 100, 200, 300 years.

20 So in conclusion, we believe there is a
21 strong basis to support the safe storage of used fuel.
22 The 1500 casks are successfully performing their
23 safety function. We are not resting on that, as I
24 think John has described, and working with DOE as
25 well. We are working on an urgent basis to address

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1 the future challenges to stay ahead of that curve.

2 We think that as we do that, improving the
3 regulatory framework, bringing it up to the modern era
4 as we did with reactors, because reactors, we're able
5 standardize, because now they had so much experience.
6 Well, dry casks are now standardized because we have
7 so much experience.

8 And looking at the system, based on 1500
9 casks we loaded and figuring out what's the smartest
10 thing to do with those 1500 casks is probably the best
11 place to start when considering extended storage. So
12 thank you for your time and I encourage the committee
13 to continue to place its focus and expertise in this
14 area.

15 CHAIRMAN RYAN: Thanks, Rod. Appreciate
16 your presentation. Any questions for Rod? Hearing
17 none --

18 MEMBER ARMIJO: I have a question.

19 CHAIRMAN RYAN: Whoops, Sam?

20 MEMBER ARMIJO: Yes. Let's say you do
21 your inspection and you find stress corrosion cracks
22 on your seaside containers. And you have a little bit
23 of information on the fabrication history so you can
24 guess, but not really solid information, what the
25 residual stresses are.

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1 What is the industry going to do then?
2 Are you going to argue that the cracks are just
3 surface cracks and they are not growing? Are you
4 going to do some sort of a periodic inspection for
5 other sites that you haven't examined? Are you going
6 to do something to mitigate that problem?

7 You know, there's a high likelihood that
8 you're going to see some cracks. That's my opinion,
9 because eventually, you'll have enough salt. If you
10 haven't been cleaning it off, you have axial welds
11 where there's residual stresses, they weren't solution
12 heat-treated, no actions taken to protect them,
13 eventually you'll have enough of a chloride
14 concentration built up and enough stress that,
15 somewhere along the line, there will be some cracks.

16 Personally, I think they'll be very
17 shallow and they are not going to grow, but now you've
18 got a dilemma. You're going to have to start
19 explaining that, and measuring that, broadening your
20 inspection, so why aren't you working right now to
21 look at that issue and what you would do to mitigate
22 it, or explain it, or deal with it, because I think
23 you guys are painting yourself into a corner.

24 MR. MCCULLUM: Well, the answer is, you're
25 absolutely right, we'd have to assess the extent of

1 condition and you're now putting us in a different
2 context from a regulatory standpoint and we have to
3 take action. We have to define that action and be
4 ahead of, you know, the potential consequences of
5 that.

6 MEMBER ARMIJO: Yes.

7 MR. MCCULLUM: And John's chomping at the
8 bit here because that's really the essence of the
9 communication plan that EPRI is working on and this
10 has been called for by, you know, very high level of
11 industry. At the Chief Nuclear Officer level they
12 have this commitment. So, John, if you want to talk
13 about your communication plan.

14 DR. KESSLER: Yes, you pretty much talked
15 about it. We are looking into NDE techniques such
16 that, if we see some indication, you know, some visual
17 we are not really sure what it is we're looking at,
18 how is it we can determine whether it is or isn't a
19 crack, and then, yes, is it through going or not, is
20 something that we're starting to look at.

21 We know that there is NDE techniques out
22 there, but NDE techniques that maybe you have to do in
23 situ because moving it something that you may not want
24 to do, is something that we're looking into. How can
25 we adapt existing NDE tools that can get in there,

1 that can survive under these conditions? We're
2 looking at that.

3 We're also starting to think about, okay,
4 if it's limited cracking and we are not relying on the
5 canister for a huge amount of structural integrity,
6 can we put some sort of patch over the crack if it's
7 limited cracking?

8 And we're starting to think about, okay,
9 how would we do that and what, again, tools would we
10 have available to get inside these systems to do it in
11 situ? And if not in situ, then we have to think
12 about, you know, what analyses that we have to do to
13 move it. So we're looking through and thinking
14 through those issues now of, what is it that we need
15 to do?

16 Certainly, if we see something, we will be
17 looking at more systems, again, to get the industry-
18 wide extent of condition as well as the, you know,
19 individual canister extended condition.

20 MEMBER ARMIJO: Well, from what I heard in
21 these presentations, you know, you got this issue of,
22 how do you assure a benign environment for this fuel?
23 So a better drying process procedure to really know
24 that there is no residual moisture or an acceptable
25 level of residual moisture, you know, is the industry

1 working on that?

2 On putting some special requirements on
3 stainless steel canisters that are destined for
4 seaside exposure requiring solution heat-treatment of
5 axial welds, if that's your only -- careful control of
6 post-weld grinding. All of these kinds of things are
7 well-known --

8 DR. KESSLER: Looking at 316, something,
9 yes.

10 MEMBER ARMIJO: -- good best practices.
11 Is the industry going to do something to truncate the
12 problem so you've got a heritage group of casks that
13 may be susceptible, are going to give you headaches
14 for a long time, but the stuff that's coming out the
15 door now is built to better standards, just like we
16 pick better materials for steam generators, or piping.

17 You know, it seems to me that the first
18 time you find some stress corrosion cracks on these
19 canisters, it's going to open up a huge mess and
20 you're going to have to deal with it. And I think you
21 can, but it's going to be very expensive and you
22 probably want to see if you could use well-known good
23 practices to cut this problem off at the pass before
24 you just keep making more casks of the same design
25 with the same inherent --

1 DR. KESSLER: Well, you've named the
2 things that could be done, I mean, right there.

3 MEMBER ARMIJO: Yes. And the other thing
4 is, I think, Einziger just told us, you're better off
5 to start with a low temperature. If you're going to
6 put this stuff in there, the amount of cladding
7 degradation, all these phenomena, are better if you
8 start at a low temperature than if you start at a high
9 temperature.

10 DR. KESSLER: Yes.

11 MEMBER ARMIJO: There's proposals to
12 expedite the unloading of fuel from spent fuel pools
13 which will push you in the direction of more hotter
14 fuel going into these casks, which is the wrong
15 direction from an ISFSI standpoint. All of these
16 things have to be thought of --

17 DR. KESSLER: And that's where risk-
18 informed thinking is essential, because you could say,
19 all right, you know, it's just so obvious we need to
20 lower peak temperatures during drying, but what does
21 that mean? Maybe we have to go to smaller canisters.

22 Maybe, you know, there's more, you know,
23 other kinds of operational stipulations that, in the
24 end, may, you know, somewhat negate, or at least have
25 to be factored into, an overall assessment as to what

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1 you want to be doing.

2 MEMBER ARMIJO: Or prove that high
3 temperature is okay.

4 DR. KESSLER: Yes.

5 MEMBER ARMIJO: Either way, but somewhere
6 along the line, near term --

7 DR. KESSLER: We've been working hard at
8 what temperatures and stress combinations are okay
9 versus not okay. Yes.

10 MR. MCCULLUM: I think one thing that's
11 important to point out here, and I really, that was a
12 good point about what we do to truncate the problem
13 going forward, is the competitive nature of the dry
14 cask storage industry. It is the most competitive
15 aspect of the nuclear business.

16 There's three major vendors out there.
17 They are all intensely competitive. Once one of these
18 cooperative programs finds anything to be worried
19 about, every single one of them is going to be wanting
20 to sell its customers on why their design is resistant
21 to that problem, which means --

22 MEMBER ARMIJO: Shame on them for not
23 being able to do that right now.

24 MR. MCCULLUM: Well, I'm not so sure
25 they're not. Yes, I'm not so sure they're not.

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1 DR. KESSLER: There's been a few changes
2 of design in some cases.

3 MR. MCCULLUM: Yes. The designs, you
4 know, it is truly, you know, the competitive aspect of
5 this is what drives rapid design improvement and we
6 anticipate that the more we learn about this, the
7 better that'll work.

8 MEMBER ARMIJO: Yes. I don't disagree.

9 DR. KESSLER: And that's one of the
10 reasons why, when we do additional inspections, we'd
11 like to get at least one inspection from all three
12 vendors.

13 CHAIRMAN RYAN: I think they would like
14 that too.

15 DR. KESSLER: Yes.

16 MEMBER SKILLMAN: The constraints that
17 will be on your inspection team at Dominion, 75
18 millirem is a very --

19 DR. KESSLER: Yes, Calvert, right.

20 MEMBER SKILLMAN: Or excuse me, Calvert,
21 is a very meager budget for what you need to
22 accomplish what you need to accomplish. So you would
23 be well-advised to make sure that you've got the right
24 inspection tool, that you have tested, and that you
25 are prepared to utilize, because the question's going

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1 to be, did you use a thick enough magnifying glass?
2 Did you encounter problems that you could have
3 anticipated, but you didn't? And therefore, have you
4 lost your opportunity?

5 DR. KESSLER: Well, let me address, and
6 specifically, for the Calvert case. Let us treat
7 Calvert as a first attempt in the sense that we're
8 going to learn better how to do the next ones from
9 this one. We're going to make mistakes so things
10 aren't going to go as well as we'd like to have.
11 We're not going to take as many data points before all
12 --

13 MR. MCCULLUM: John, if I could interrupt.
14 I should point out that the Calvert inspections have
15 already been before the ALARA challenge board and, you
16 know --

17 DR. KESSLER: Thank you.

18 MR. MCCULLUM: -- they are asking those
19 questions. How are we going to make best use? And
20 I'm sure that --

21 DR. KESSLER: Putting in temporary
22 shielding and things like that.

23 MR. MCCULLUM: Yes. The feedback from
24 that is going to help make sure that we've got to
25 think things through in advance there.

1 DR. KESSLER: Right. Like, for example,
2 this dry run they went through to make sure that you
3 get the tools in and out efficiently. They're sitting
4 there with stopwatches. You know, they're estimating
5 where the dose streaming will be around the edges
6 there and they're figuring out, you know, how many of
7 these samples can we do? And if we're limited to how
8 many samples, well then, which ones do we do and in
9 what positions?

10 We're thinking through all of that right
11 now just for the Calvert. And then for the next ones,
12 yes, we may have improved tooling, more remote
13 tooling, something like that. We know that Idaho is
14 developing a robotic arm for, you know, one of these
15 new home-type systems. Maybe that's something we
16 could begin --

17 CHAIRMAN RYAN: Well, I'm thinking about
18 what you just said, and I'd like to interrupt you if
19 I may. I think too that, while the ALARA goal of 75
20 millirem is certainly challenging, I think if it has
21 to be 95 in order to get the right data, that can't be
22 closed off.

23 You know, 75, there's nothing magic about
24 75 in terms of the risk to the workers.

25 DR. KESSLER: You're talking to the wrong

1 guy, Mike.

2 CHAIRMAN RYAN: Okay.

3 (Simultaneous speaking)

4 DR. KESSLER: Yes, but the point is, I
5 have no idea where they're at.

6 CHAIRMAN RYAN: All right.

7 DR. KESSLER: You know, Calvert is the
8 site, so I can't --

9 CHAIRMAN RYAN: Well, maybe if there's a
10 compelling argument, that could be revisited, but some
11 small increment that might help get the job done with
12 an additional inspection. You know, but I would hate
13 to see, you know, that ALARA becomes a negative of,
14 you know, not allowing the collection of all the data
15 you need as opposed to 80 percent of it, which is not
16 all that great, maybe, or maybe it's okay. I don't
17 know.

18 But, you know, I think you just have to
19 balance the research plan, and the ALARA plan, and
20 some balance to say, what's the right mixture, and it
21 can't be because we've decided up-front the number is
22 75.

23 MEMBER SKILLMAN: Let me finish my first
24 point and make my second point. There's going to be
25 a high anticipation of success and that requires that

1 there be enough practice and rehearsal under real
2 conditions, or simulated conditions, that you've got
3 the greatest chance of being highly successful.

4 DR. KESSLER: I'll say.

5 MEMBER SKILLMAN: The flipside is, and
6 respecting Dr. Armijo's point, on the one hand, you
7 may find some, or a lot, of cracking. You need to be
8 prepared for the message that comes with that, but the
9 flipside is also true. For some reason you should
10 discover there isn't any, there will need to be an
11 explanation and the explanation can't be, we didn't
12 use a thick enough magnifying glass.

13 There has to be an explanation that says,
14 you know what? It's possible that there wasn't going
15 to be any and we've confirmed that there's not any.

16 DR. KESSLER: You're right. What is nice
17 is that, we have some experimental data, which we're
18 trying to add to, that says, these are the combination
19 of conditions we need to support stress corrosion
20 cracking. So if we don't see any, and the
21 experimental data suggests we shouldn't have seen any,
22 then maybe that's helpful, but we're not going to stop
23 at one inspection.

24 We need to do more just to see whether it
25 was just a fluke, or we didn't happen to see it, or

1 something.

2 MEMBER ARMIJO: The other difficult thing
3 when you do visual inspections, you see something, is
4 it a crack, or isn't it a crack?

5 DR. KESSLER: Exactly.

6 MEMBER ARMIJO: Is it, you know, a weld
7 crevice? And so you have all this problem so would
8 you have some sort of a supplementary technique to
9 assure yourself, this indication is really a crack,
10 whether it's a penetrant inspection, or some other
11 way, but, you know, in real life, that's what happens
12 when you do these inspections.

13 You get information that isn't quite clear
14 and so --

15 DR. KESSLER: Right.

16 MEMBER ARMIJO: Going back to the point of
17 the ALARA budget, you don't have a chance to resolve
18 it, because if you've met this hard constraint and --

19 DR. KESSLER: Well, my guess is --

20 MEMBER ARMIJO: -- go down the tubes.

21 DR. KESSLER: -- if we saw something,
22 they'd revisit the ALARA budget. But also, one of the
23 things that's already been done for the initial
24 license granting was that, Constellation did a
25 consequence analysis in the sense of, what if there is

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1 a crack? What kind of offsite doses would we get?

2 And my understanding is, the doses are
3 pretty small. We're going to go back and look at that
4 too, if for no other reason than to say, are we in a
5 big hurry to address this issue and fix it, or do we
6 have some time to make sure we can really inspect it,
7 et cetera?

8 So we're kind of thinking through that too
9 in terms of, you know, do we have to, like, throw
10 sandbags at the thing or something else? I don't
11 think so, but --

12 MEMBER ARMIJO: I don't think so either.

13 DR. KESSLER: -- you know, you have to
14 think through all those things, and we're doing that.

15 CHAIRMAN RYAN: Fair enough. Okay. We're
16 kind of running into time. We got Jim, who's wanting
17 to wrap up over there. So, Jim, come on up.

18 MEMBER RAY: Okay. While he's coming up,
19 just so not to extend the time, you know, as far as I
20 know on any of the technical things we talked about
21 here, there's a high likelihood of a benign
22 resolution. But I guess the last comment that was
23 made, I'm a little concerned with the idea that, well,
24 maybe, something different ought to be done now. Sam
25 mentioned wanting --

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1 MEMBER ARMIJO: I just want to make sure
2 that it's conclusive.

3 MEMBER RAY: Well, but there are others,
4 such as, supposing for just a moment somebody said,
5 okay, high burnup fuel cannot go, period, into dry
6 cask storage, or at least not any that we know of
7 today, what would that do? It'd be better to know
8 that sooner than later, wouldn't it?

9 MEMBER ARMIJO: Sure.

10 MEMBER RAY: Or if you're going to do it,
11 you're going to have to change something every 50
12 years, so we've got to establish a trust fund to do
13 that down the road. I mean, it's just better to push
14 this along, it seems to me like, and reach these
15 conclusions because they affect things that are going
16 on today.

17 MEMBER ARMIJO: Sure.

18 MEMBER RAY: And the assumption thought
19 that, oh, well, whatever the problems are, we'll
20 manage them in the future, I'm not sure is the right
21 outcome. Anyway, that's the end of my speech.

22 CHAIRMAN RYAN: Well, that's an important
23 point, Harold. I think there is a wall that you can
24 run into that you can't climb over it because it costs
25 too much, or it takes too much time, or resources, or

1 whatever it is, so it's a good caution, actually, that
2 we might ought to think about having in the letter.

3 MEMBER RAY: It's the one thing that
4 concerns me out of all of this because, just the mere
5 idea that something that you designed for one purpose
6 can suit a quite different purpose, extended long-term
7 storage, without any changes at all, is almost, you'd
8 say, a miracle that that happened.

9 And so, you know, it's that kind of
10 concern that I'm articulating here. And with that,
11 I'll shut up.

12 CHAIRMAN RYAN: Thanks, Harold.

13 DR. RUBENSTONE: I will make this brief
14 because I don't want anyone to miss the transit of
15 Venus. That last comment, I think, is important and
16 that's, to me, the motivation of why we're addressing
17 this issue now, why we're getting started on this when
18 we're talking about time frames that are long from
19 now, but decisions you make now, especially if you
20 don't want to have to re-handle things, are important
21 for long time periods.

22 So I appreciate the committee's interest
23 in this and I think this has been a good discussion.
24 I want to thank the outside, the non-NRC participants
25 who came in to give us the industry perspective,

1 because I think that was a valuable counterbalance so
2 you can see how they're addressing the problem
3 compared to the staff's approach.

4 Just a quick recap, there's a limited
5 number of things we owe you. A reference or two on
6 the, kind of, state of understanding of fuel swelling
7 and how that can affect --

8 MEMBER ARMIJO: Particularly low
9 temperature alpha decay.

10 DR. RUBENSTONE: Yes. And Bob has taken
11 that as his action. We ready to come before your full
12 committee on July 11th. Any guidance you can give us
13 about what areas to stress, what things not to talk
14 about, would help us --

15 CHAIRMAN RYAN: Okay. Maybe what we'll do
16 is, Chris and I can get with you at a little bit later
17 time and talk that over in a little bit more detail
18 than we can do here.

19 DR. RUBENSTONE: Yes.

20 CHAIRMAN RYAN: But, yes, we'd love to do
21 that.

22 DR. RUBENSTONE: Right. And then the one
23 other action is, you'd like to know when we have
24 something more to tell you and when is the best time
25 to come back to you.

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1 CHAIRMAN RYAN: Sure.

2 DR. RUBENSTONE: And that's all I've got
3 as actions out of this. So I think, from my point of
4 view, this was quite successful, and Jeff's waving his
5 hand.

6 MR. WILLIAMS: I was just going to say, we
7 owed him one reference. And by the way, I think Bob
8 has that reference because he's been part of the ESCP
9 committee.

10 DR. RUBENSTONE: Oh, the --

11 MR. WILLIAMS: The gap analysis priority
12 report.

13 DR. RUBENSTONE: If you're comfortable
14 with us providing that, or John providing it, maybe
15 that's a better path. Why don't you talk to
16 Christopher Brown and you guys can work that out.

17 CHAIRMAN RYAN: Thank you. That's great.
18 Anything else for the presenters or the topic? Jim,
19 thank you very much and -- I'm sorry, one last time
20 around. Sam?

21 MEMBER ARMIJO: I have no more.

22 CHAIRMAN RYAN: Dennis?

23 MEMBER BLEY: Yes. I'm not an expert on
24 this, but I thought I'd toss it in because we talked
25 about a lot of things about this coming examination.

1 We talked about magnification and some research we
2 reviewed a couple of years ago, you know, it's not
3 just the magnification, it's the lighting and the
4 experience of the guys trying to do the readings.

5 And they range from really good at picking
6 up cracks to very bad, so I'm hoping all that's in
7 consideration before they start marching through this
8 thing.

9 CHAIRMAN RYAN: Okay. Steve.

10 MEMBER SCHULTZ: Yes. I'd like to just
11 put in the comment that this is caused, for me, a
12 sense of urgency associated with the technical work
13 that is ongoing related to these issues that come from
14 the Blue Ribbon Committee and the mission going
15 forward. And where the staff, of course, comes in is
16 this risk-informed approach associated with this
17 decision making.

18 And as Dr. Armijo has indicated, we're
19 following, very closely, some very important decision
20 making associated with spent fuel pool movement to
21 canisters, dry storage, and that decision making could
22 come upon us very rapidly. And it'd be a real shame
23 if we didn't make the right decisions. And, of
24 course, this has a clear nexus to it.

25 So I think what we didn't hear today, and

1 that is, firmer schedules about how this is going to
2 play out, we're going to have to identify that as we
3 move forward to make these broader policy decisions
4 about what we should do on reactor sites going
5 forward.

6 CHAIRMAN RYAN: Thank you. Jack.

7 MEMBER SIEBER: No.

8 CHAIRMAN RYAN: I share Steve's comment.
9 You know, I think I didn't have any sense of urgency
10 this morning, but I feel a little bit more that
11 there's a lot of moving parts here and some are
12 moving, perhaps, in ways that are clear and some maybe
13 not so clear.

14 And that there's a lot of work to get how
15 the whole machinery is going to work together in a
16 time-efficient way so that we have fuel out of the
17 pools where it should be out of the pools, in casks
18 where it should be, and, you know, we could really,
19 kind of, choke up the system if we're not correct in
20 all the moving parts decisions that have to be made in
21 this process.

22 So I kind of join that comment that, you
23 know, my sense of urgency has been heightened a little
24 bit and it's clear that you've got the moving parts,
25 you know, well in hand in terms of understanding what

1 these parts are and the plans forward to address them
2 well and, kind of, put some clarity in this.

3 So I think I applaud your efforts to take
4 the clouds away and, you know, make it a clearer path
5 forward.

6 MEMBER SCHULTZ: Okay. I would certainly
7 agree with that too.

8 CHAIRMAN RYAN: All right. Well, thank
9 you very much. I think with that, unless there are
10 any other public comments. We had somebody on the
11 bridge line earlier. Are there any comments from the
12 bridge line? Are there any comments from the bridge
13 line? Hearing none from the bridge line, are there
14 any comments in the room?

15 With that, we'll adjourn the subcommittee
16 meeting and thank you all very much.

17 (Whereupon, the above-entitled matter was
18 concluded at 4:53 p.m.)

19

20

21

22

23

24

25

Regulation of Future Extended Storage and Transportation Technical Information Needs

James Rubenstone

Office of Nuclear Material Safety and Safeguards
U.S. Nuclear Regulatory Commission

Advisory Committee on Reactor Safeguards
Subcommittee on Radiation Protection and Nuclear Materials

June 5, 2012



Overview

- Changing policy environment
- Regulatory framework—current and future
- Extended storage and transportation—technical information needs
- Next steps





Current Policy Environment

- U.S. national policy for disposition of spent nuclear fuel is in transition
 - Extended (dry) storage of spent fuel may be necessary
 - Alternative disposal options may emerge
- NRC's mission remains the same – ensure the safe and secure use of radioactive materials while protecting people and the environment
- Consistent with Commission direction, NRC staff is preparing for potential changes in policy
- BRC recommendations may provide some insight



Spent Fuel Storage: Dry Storage Systems



- Canister and integrated systems
- Horizontal and vertical orientations

- About 18,000 MTU commercial SNF currently in dry storage
- About 1,500 casks currently loaded





Spent Fuel Storage and Transportation: Framework

- Storage
 - 10 CFR Part 72
 - Term certificates and licenses
 - Aging management plans for renewal
 - Multiple renewals allowed
- Transportation
 - 10 CFR Part 71
 - Term certificates with renewal
 - Certification generally separate from storage





Extended Spent Fuel Storage and Transportation: Needs

- Potential changes to regulations and guidance to accommodate extended storage and transportation of long-stored spent fuel
- Technical information to inform potential regulatory changes and support future licensing reviews
- Identify technical issues associated with long-term storage
- Perform focused research on technical issues of regulatory significance



Extended Spent Fuel Storage and Transportation: Technical Needs

- Focus on potential degradation phenomena for dry storage systems, structures, and components
- Consider impact on performance of safety functions for storage and transportation
- Consider understanding necessary for regulatory review



Draft Report for Comment

**Identification and Prioritization of the
Technical Information Needs Affecting
Potential Regulation of Extended Storage
and Transportation of Spent Nuclear Fuel**

May 2012



Extended Spent Fuel Storage and Transportation: Methodology

- Used previous studies of technical gaps
 - NRC – Savannah River National Laboratory
 - Department of Energy
 - Nuclear Waste Technical Review Board
 - Electric Power Research Institute
- Level of knowledge for degradation processes
 - Time and conditions of initiation
 - Rate of progression
 - End state
- Impact on meeting regulatory criteria



Extended Spent Fuel Storage and Transportation: Criteria

- Design criteria – Safety functions
 - Confinement
 - Criticality control
 - Radiation shielding
 - Structural integrity
 - Thermal control
- Ability to retrieve stored fuel by normal means
- Possible impacts for transportation of long-stored spent fuel



Extended Spent Fuel Storage and Transportation: Results

- High priority technical information needs have
 - Overall low level of knowledge for one or more degradation questions
 - Overall high impact on regulatory criteria
- Crosscutting issues affect multiple aspects
- Several degradation processes interrelated
- Some information needs overlap with current licensing topics



Extended Spent Fuel Storage and Transportation: Technical Needs

- High priority degradation areas :
 - Stress corrosion cracking of stainless steel canister body and welds in marine atmosphere
 - Degradation of cask bolts
 - Effects of fuel pellet swelling and fuel rod pressurization on cladding stress
- High-priority cross-cutting areas :
 - More realistic thermal model calculations
 - Effects of residual moisture after canister drying
 - In-service monitoring methods for dry storage systems



Extended Spent Fuel Storage and Transportation: Technical Needs

- Other (nearly as) high priority degradation areas:
 - Propagation of cladding flaws, cladding fatigue, and low temperature creep (stress dependent)
 - Fuel assembly hardware corrosion and fatigue embrittlement
 - Neutron absorber degradation
 - Microbially influenced corrosion
 - Concrete degradation in unexposed areas



Extended Spent Fuel Storage and Transportation: Regulatory Areas

- Long term cladding integrity and retrievability
- Long-term financial assurance
- Decommissioned sites
- Physical security
- Risk informed regulations
- Integration of storage, transportation, and disposal regulations
- Coordination with current licensing process improvements



Extended Spent Fuel Storage and Transportation: Next Steps

- Finalize report on *Technical Information Needs Affecting Potential Regulation of Extended Storage and Transportation* after public comments
- Complete research plan for technical investigations
- Assess potential regulatory issues
- Continue technical investigations in selected high-priority areas
- Engage industry and other stakeholders
- Monitor outside technical work



Spent Fuel Storage and Transportation: BRC

Blue Ribbon Commission proposed a national nuclear waste management strategy with eight key elements, including:

- A new, consent-based approach to siting future nuclear waste management facilities
- Prompt efforts to develop one or more consolidated storage facilities
- Prompt efforts to prepare for the eventual large-scale transport of spent nuclear fuel and high-level waste to consolidated storage and disposal facilities when such facilities become available



Spent Fuel Storage and Transportation: BRC

- NRC staff reported to Commission on implications for NRC (SECY-12-0037; in ADAMS at accession number ML120410684)
- DOE is expected to respond to the BRC report this summer



Potential Implications

- Consolidated facilities?
- Multiple transportation stages?
- Multiple handling stages?
- Statutory changes?



Conclusions

- NRC is continuing to perform its mission while preparing for potential policy changes
- Initial NRC staff efforts have defined tasks and developed plans and schedules
- Draft report for technical needs been issued for public comment
- Staff is completing technical work plans, examining regulatory areas, and has begun some technical work
- Staff is continuing interaction with public, industry, and other stakeholders

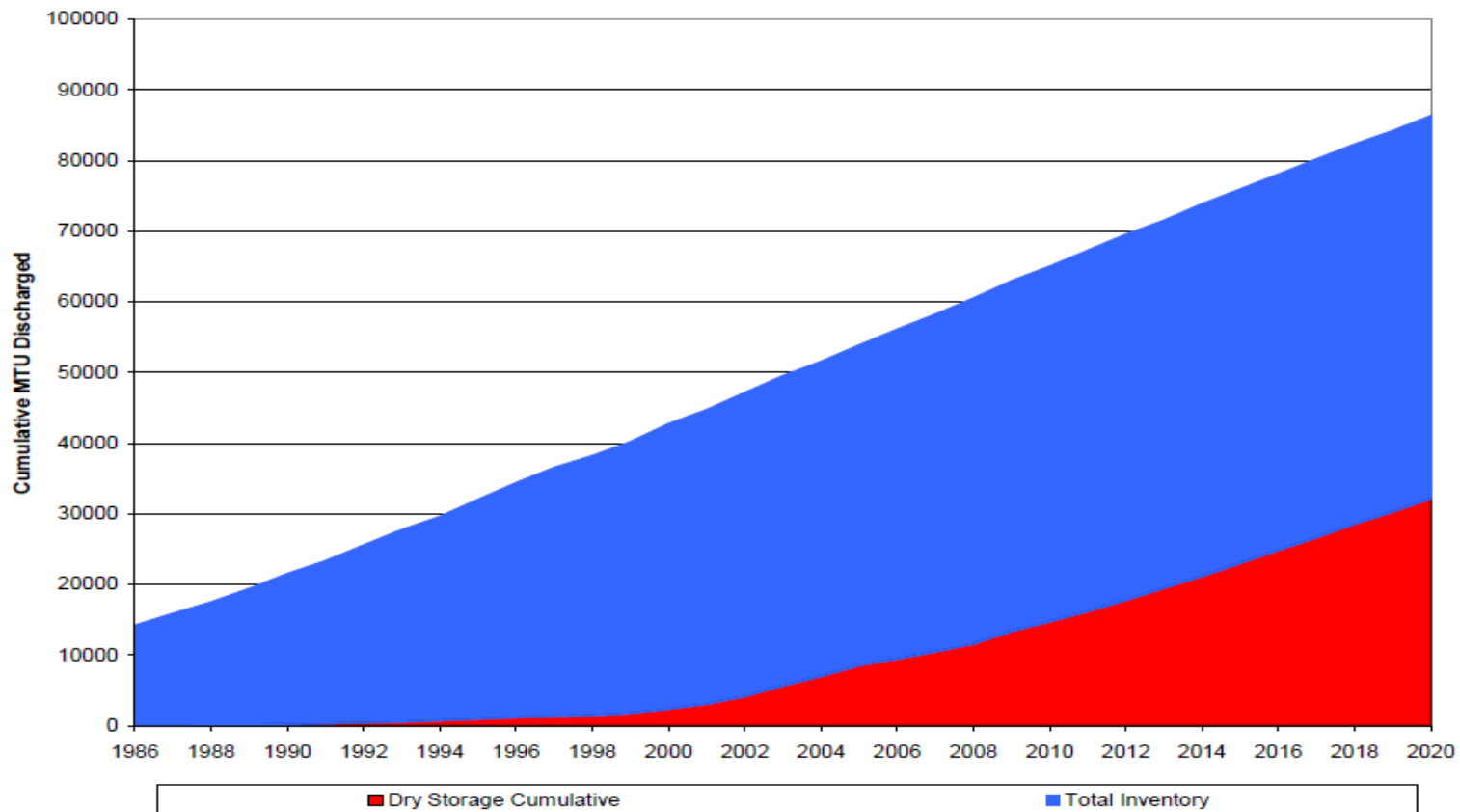


Backup Slides





Spent Fuel Storage: Historical and Projected Spent Fuel Discharges

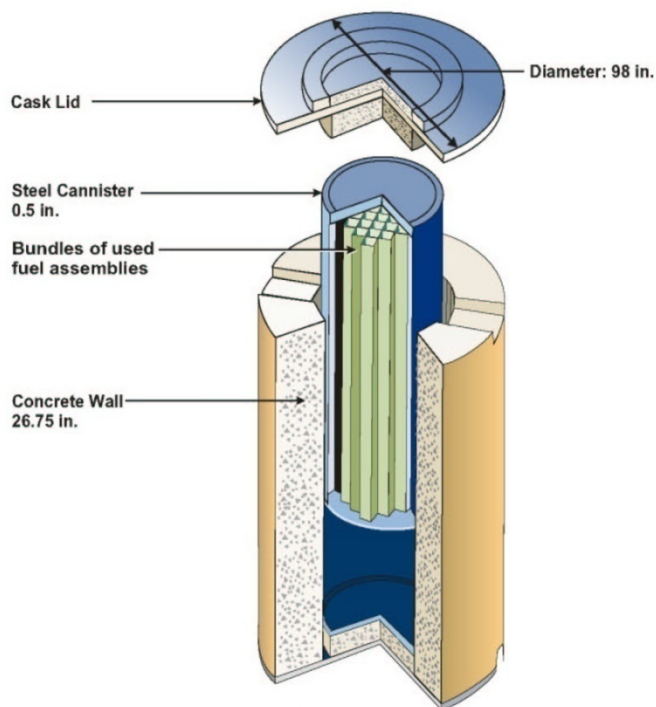


Source: *Impacts Associated with Transfer of Spent Nuclear Fuel from Spent Fuel Storage Pools to Dry Storage After Five Years of Cooling*, Electric Power Research Institute, 2010



Spent Fuel Storage: Dual Purpose Systems

Dual Purpose Storage Cask*

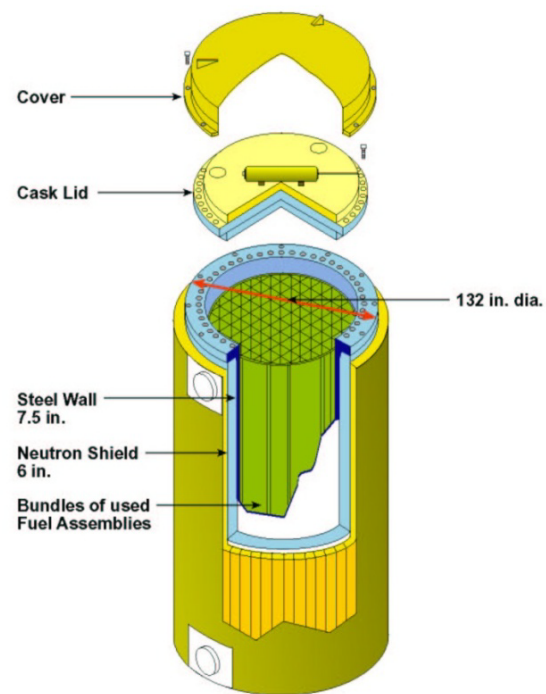


(Holtec International
HI-STORM 100)

Overall Length: 197 to 225 in.
Loaded Weight: 360,000 lbs.
Typical Payload: 24 PWR Bundles

* Storage and Transportation

Dual Purpose Cask*

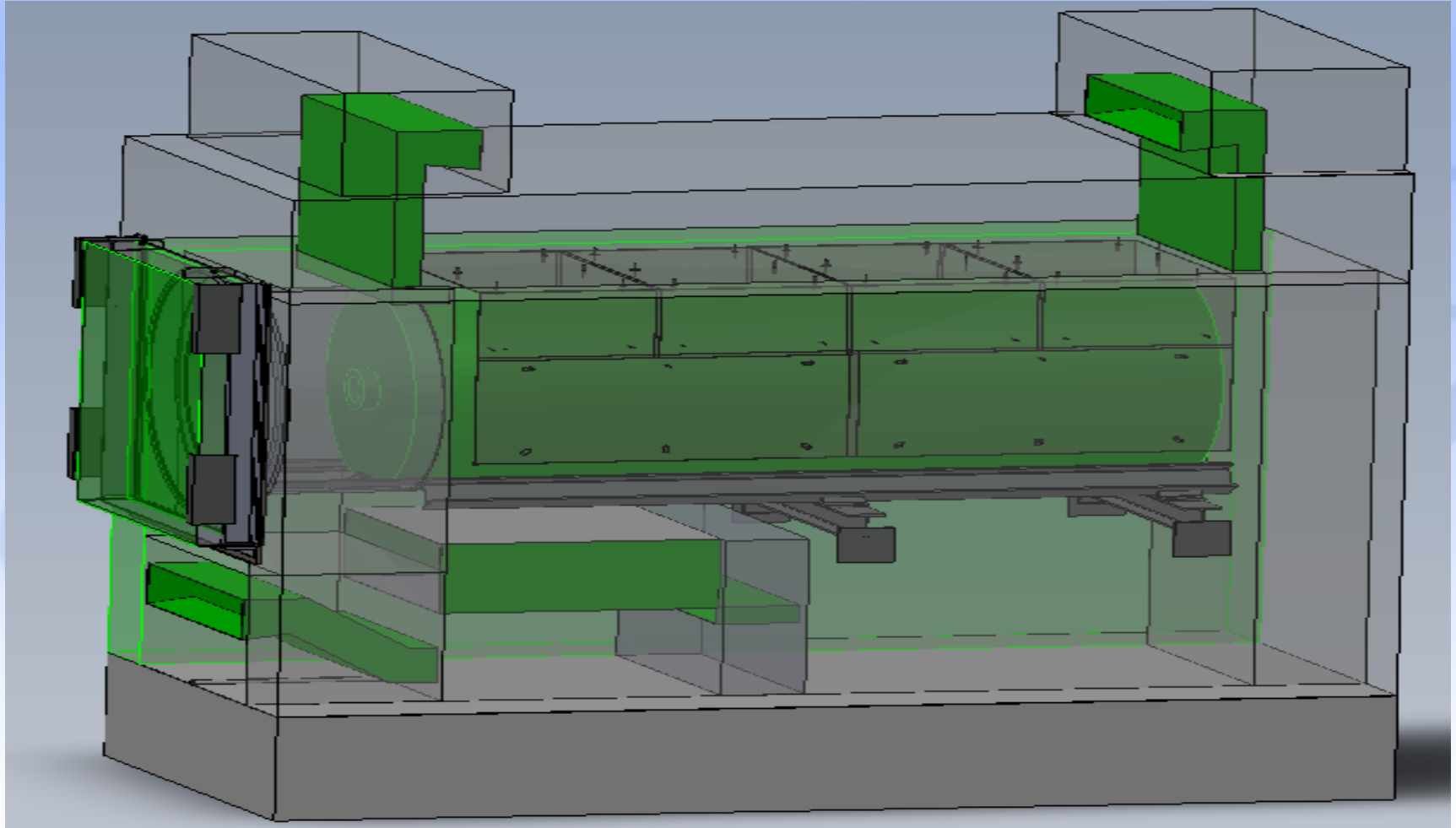


(Transnuclear TN-68)

Overall Length: 178 in.
Loaded Weight: 240,000 lbs.
Typical Payload: 68 BWR Bundles



Spent Fuel Storage: NUHOMS Canister System





Extended Storage Technical Issues

John Kessler

Manager, Used Fuel and HLW Management Program

ACRS Subcommittee on Radiation Protection & Nuclear Materials

5 June 2012

Extended Storage – an International Issue

- Most “nuclear” countries face extended storage
 - No reprocessing
 - No disposal
 - Centralized (consolidated) storage is still storage

R&D in Several Countries Already Well Underway – a *Few* Examples:

- SS dry storage canister degradation (e.g., Japan, NRC (SwRI))
- Continued data collection from the CASTOR V/21 at INL (US, Japan)
- Bolted casks: seals and bolts degradation (Japan, Germany, US, others)
- Periodic visual inspection of cask internals (Japan)

EPRI Initiates Extended Storage-specific Work in 2009

- Recognized need for international collaboration
- Share existing information
- Are there common technical issues for future technical work?
- Identify specific industry needs for R&D

“Extended Storage Collaboration Program” (ESCP) Launched in 2009

Bring together US and international organizations engaged with active or planned R&D

- Storage and transportation system vendors
- Regulators and their R&D contractors
 - (e.g., US NRC/ SwRI, CSN, UK DfT and NIL, BAM)
- National waste management organizations
 - (e.g., US DOE, ENRESA, PURAM, NWMO)
- R&D organizations
 - (e.g., US national labs, EPRI, CRIEPI, KAERI)
- Industry (utilities/cask vendors)
 - (e.g., France, Germany, Japan, Netherlands, Spain, S. Korea, Switzerland, Taiwan, UK, Ukraine, USA)

EPRI Extended Storage Collaboration Program (ESCP)

- Purpose: “Provide the technical bases to ensure continued safe, long-term used fuel storage and future transportability”
- Modeled on prior dry storage license extension research
- Phased approach
 - ✓ Phase 1: Review current technical bases and conduct gap analysis for storage systems
 - Phase 2: Conduct experiments, field studies, and additional analyses to address gaps (already underway)
 - Phase 3: Coordinate research that results in a program documenting the performance of a dry storage system loaded with high burnup fuel (>45 GWd/MTU)

ESCP Subcommittees

- Fuel/Internals
- “Marine environments”
- Non-destructive evaluation (NDE)
- Concrete Systems
- High burnup confirmatory demonstration
- “International”

Gap Analyses: Highest Priority Items

- Welded SS canisters SCC
- High burnup cladding: hydride effects (reorientation, embrittlement)
- Bolted casks:
 - Corrosion of bolts
 - Embrittlement and mechanical degradation of bolts
- Fuel pellet swelling

Cross-Cutting Needs

- Improved thermal modeling
- Stress profiles
- Degradation monitoring systems
- Adequacy of drying
- Sub-criticality: burnup credit
- Examine casks at INL (DOE)
- Retrievability: fuel transfer options

Modeling and Laboratory Testing are Underway

- Modeling
 - Improved heat transfer models (PNNL, vendors)
- Laboratory testing *examples*
 - SS SCC
 - Identify conditions supporting SS SCC (CRIEPI, NRC/SwRI)
 - Correlate marine atmosphere to salt deposition (CRIEPI)
 - Bolted systems
 - Bolt degradation (BAM)
 - Seals degradation (BAM, CRIEPI)
 - Adequacy of drying (NRC/SwRI, DOE)

Next Step: Field Inspections and Large-scale Testing

- In situ inspections of SS canisters
- Full-scale, high burnup confirmatory data collection (the “demo” program)

EPRI Plans for In Situ Inspection of SS Canisters

SCC of Welded Canisters – What Do We Know?

For stress corrosion cracking you need:

- Susceptible material (austenitic stainless steels; e.g. 304, 316)
- Tensile stress (residual weld stress)
- Corrosive environment

Environment parameters affecting susceptibility of SCC

- Salts in the air
- Deliquescence
 - Surface temperature
 - Humidity

Studies have shown SCC can occur on canister materials under lab conditions

What we don't know ...

What are the conditions on actual canisters?

Inspection #1: Calvert Cliffs (late June 2012)

- ISFSI ~ ½ mile from Chesapeake Bay
- Canisters in service for > 15 years
- Low decay heat canisters
- Two canisters to be inspected
 - Aging management inspection for license renewal
 - Marine environment effects

General Inspection Plans

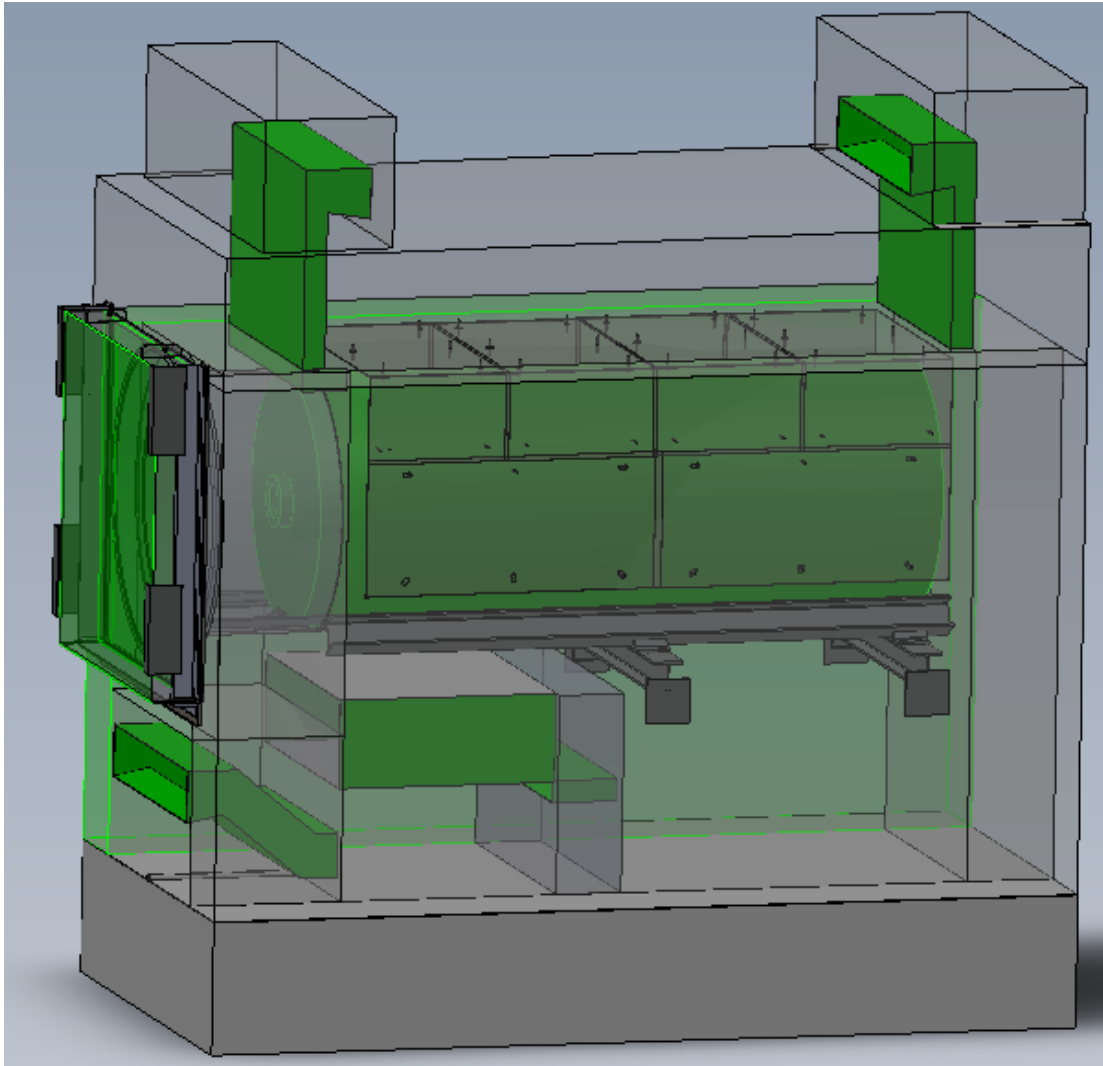
Scope of inspections:

- Visual
- Temperature
- Surface contaminants

Additional data collection on environment

- Air temperature & humidity
- Salt content in air

Calvert Cliffs Visual Inspection through NUHOMS Air Outlets



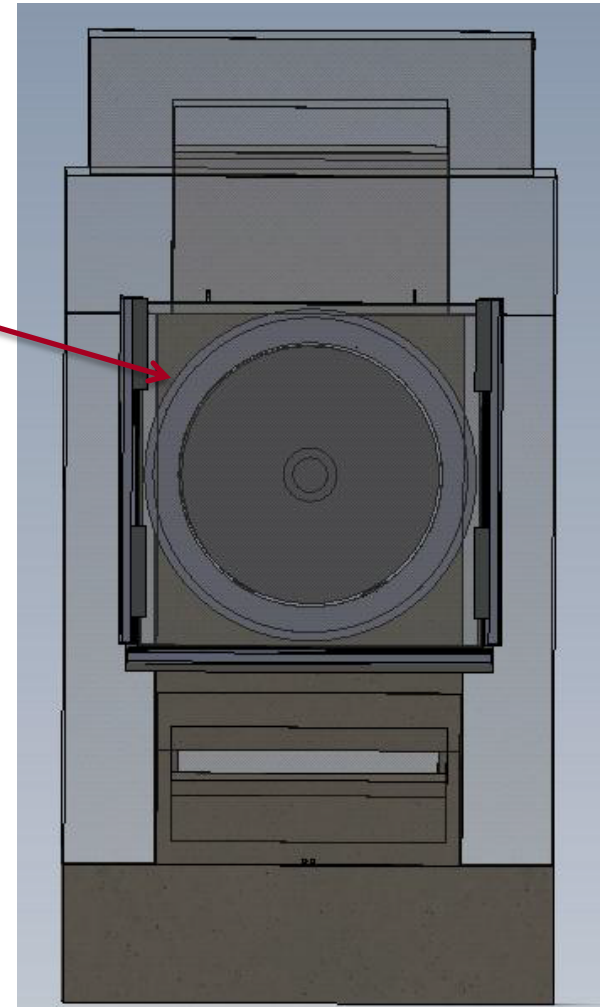
Calvert Cliffs
NUHOMS Design

Calvert Cliffs Surface Contaminant and Temperature Measurements through Front (remove door)

- Tool to access canister side through $\frac{3}{4}$ -inch gap
- Temporary shielding

Canister surface temperature

- Altered air flow may affect canister temperature
 - Thermography immediately after door raised
- Thermocouple at several radial and axial locations



TN Surface Contaminant Inspection Plans for Calvert Cliffs

- Wet (e.g. “Salt Smart[®]”)
 - Qualification testing for temperature and range of concentrations expected
 - May not work on upper surfaces that have a layer of “dust”
- Dry (scraping, brushing, vacuum)
 - More complicated tool design and construction
 - Space and weight constraints
 - Best for upper surfaces to collect “dust”
- Plan to use both



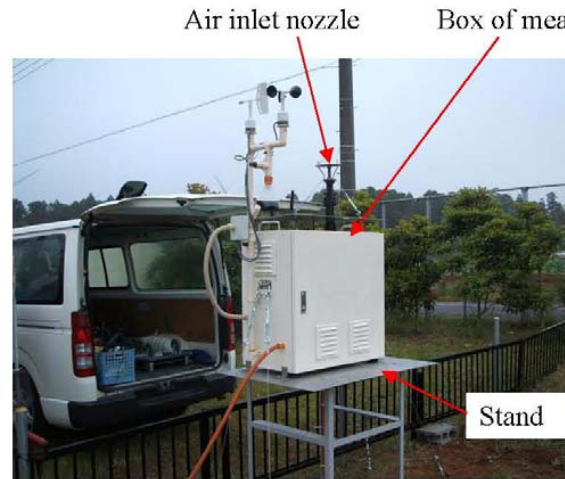
Generic External Environment Data Collection Plans

Air temperature & humidity

- Install devices at inlet and outlet

Salt content in air

- Install air sampler in vicinity of ISFSI



Outside view

Inside view

Size(Box of measurement device): 700 × 700 × 400mm

Weight: 60 kg

Power supply: 100V (20A)

Calvert Cliffs Marine Environment Inspection Schedule

- ✓ Salt Smart[®] qualification testing complete
- ✓ Tooling design complete, fabrication underway
- ✓ Functional test: 5/24-5/25
- Inspection: 6/27-6/30
- Environmental monitoring later

Future SS Canister Inspection Plans

- Prefer (initially):
 - Near salt water body
 - Long time in service
 - Low canister surface temperature ($< 80\text{-}100^{\circ}\text{C}$)
- Coordinate with other inspection activity if possible
- Develop inspection method to minimize dose

EPRI requested additional utility volunteers

7 utilities expressing interest to date

DOE will provide additional co-funding to support inspections through end of FY2013

Full-scale, High Burnup Confirmatory Data Collection (“high burnup demo”) Plans

Confidence in understanding longer-term behavior of dry storage system requires

- Model development and benchmarking data
- “Separate effects testing”
- Confirmatory testing under “prototypic” conditions
 - Full scale
 - Representative dry storage conditions
 - Drying process and inerting
 - Thermal evolution
 - Geometry
 - Prefer multiple high BU fuel types (if possible)

High Burnup Demo Objectives

- Confirmatory data to support
 - Thermal models
 - Behavior of cask internal components (fuel, cladding, assembly hardware, baskets, neutron absorber)
- Avoid rewetting the fuel after initial loading

High Burnup Demo Activities

Industry desire to keep this short

- Obtain “t=0” data from sister rods
 - Profilometry
 - Cladding properties (hydrogen content and initial orientation, mechanical, internal gas content)
- Modify existing cask with a special lid that includes
 - Thermocouples
 - Gas sampling
- Load cask and emplace modified lid
- ***Data collection through lid begins immediately***
 - Capture temperature and gas evolution during drying
 - Continue temperature measurements and periodic gas sampling
- After X years (TBD), re-open, remove rods, visually inspect for degradation
 - Rods for destructive exams to compare to “t=0”
 - Option to perform exams on internals

High Burnup Demo Option that Keeps Startup Time Short

- Initiate the demo at a reactor site
 - Avoids up-front transportation to a national lab
 - Avoids having to wait for a full-scale hot cell to be funded and constructed
 - Keeps costs low(er) prior to test initiation
- Dominion-TN proposal (start test in 3-5 years)
 - Willing host (North Anna or Surry)
 - Multiple, high burnup fuel types
 - Partner with a cask vendor supplying cask(s) at low cost
 - EPRI providing funding for instrumented lid design
 - Looking for co-funding

Together...Shaping the Future of Electricity



**U.S. DEPARTMENT OF
ENERGY**

Nuclear Energy

DOE Efforts on Extended Storage and Transportation

**ACRS Meeting of the Subcommittee on
Radiation Protection & Nuclear Materials**

**Extended Storage and Transportation (EST)
Safety Basis**

**Jeffrey Williams, Deputy Director
DOE-NE Office of Nuclear Fuel Disposition Research &
Development**

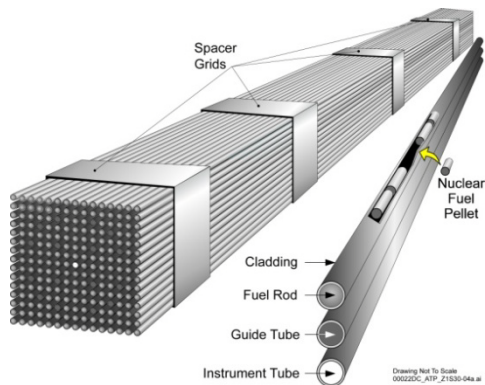
**June 5, 2012
Rockville, Maryland**



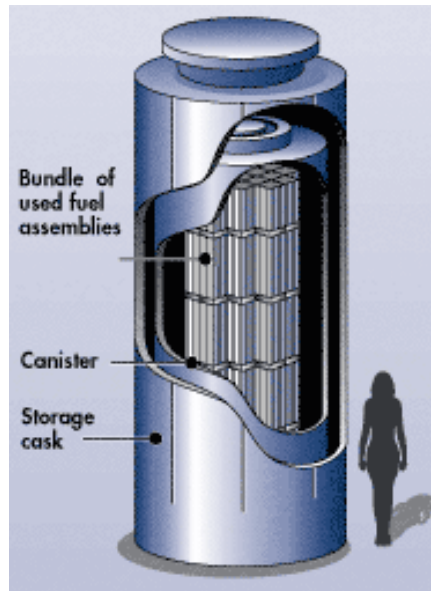
Contents

Nuclear Energy

- Overall Storage and Transportation Objectives
- Major Activities
- Collaborations



<http://energy.gov/sites/prod/files/styles/>



www.nrc.gov/waste/spent-fuel-storage/



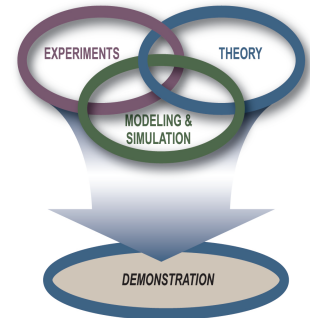
www.connyankee.com/



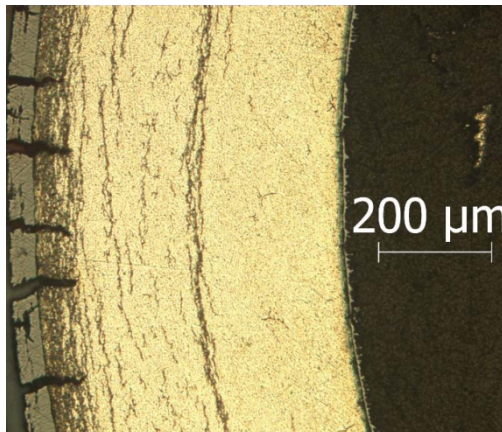
Storage and Transportation Objectives

Overall Objectives:

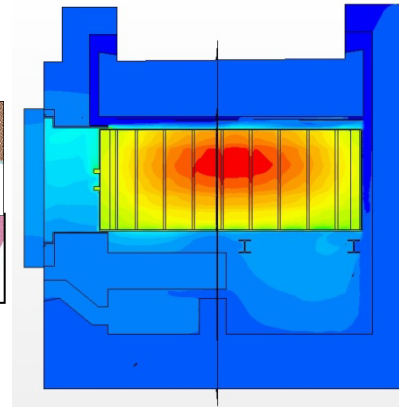
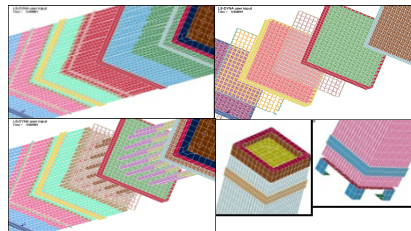
- Develop the technical bases to demonstrate used fuel integrity for extended storage periods.
- Develop technical bases for fuel retrievability and transportation after long term storage.
- Develop the technical basis for transportation of high burnup fuel.



*Science based,
Engineering driven*



Billone, Liu; Argonne



Wagner, Adkins; ORNL



'Jones 2010.ppt',
Calvert Cliffs Dry Fuel Storage
and Industry Lessons Learned



Storage and Transportation Major Activities

■ Five major activities are designed to define the work to address the objectives

- R&D Investigations
- Engineered Materials – Experimental
- Engineering Analysis
- Field Testing
- Transportation



R&D Investigations

Scope & Status

- Refine last year's Level 1 Technical Data Gap Rpt
- Review of identified data gaps relative to external studies
- Develop Aging Management Plans for storage system safety components

Gap	Likelihood of Occurrence	Consequences	Difficulty for Remediation	Importance for Licensing	Importance for Licensing
Cladding – annealing	3/2	2	3	8/7	MH/M
Cladding - H2 effects, reorientation and embrittlement	4/4	3	3	10/10	H/H
Cladding - H2 Effects, DHC	3/4	3	3	9/10	MH/H
Cladding - Oxidation	1/1	3	3	7/7	M/M
Cladding - Creep	3/3	2	3	9/9	MH/MH
Assembly Hardware – SCC of lifting hardware and spacer grids	2/2	2	3	8/8	MH/MH
Neutron Poisons - Thermal aging effects	4/4	3	3	10/10	H/H
Neutron Poisons - Creep	1/2	2	2	6/7	M/M
Neutron Poisons - Embrittlement and cracking	2/3	3	3	8/9	MH/MH
Neutron Poisons - Corrosion (blistering)	2/2	2	2	7/7	M/M
Welded Canister - Atmospheric corrosion	4/4	4	3	11/11	VH/VH
Welded Canister - Aqueous corrosion	4/4	4	3	11/11	VH/VH
Bolted casks - Thermomechanical fatigue of seals and bolts	4/4	4	2	11/11	VH/VH
Bolted casks - Atmospheric corrosion	4/4	4	2	11/11	VH/VH
Bolted casks - Aqueous corrosion	4/4	4	2	11/11	VH/VH
Concrete Overpack - Freeze-thaw	2/4	1	1	4/6	ML/M
Concrete Overpack - Corrosion of embedded steel	2/4	1	1	5/7	ML/M

Impact

- This prioritization informs the experimental and analysis work

FY13

- Accelerate experimental work on hydride cladding and SS canister corrosion

Two high priority technical issues need to be addressed in the near term:

- *hydride effects on cladding integrity for high burnup fuels*
- *general corrosion and SCC of SS canisters storing fuel*



Engineered Materials - Experimental

Scope & Status

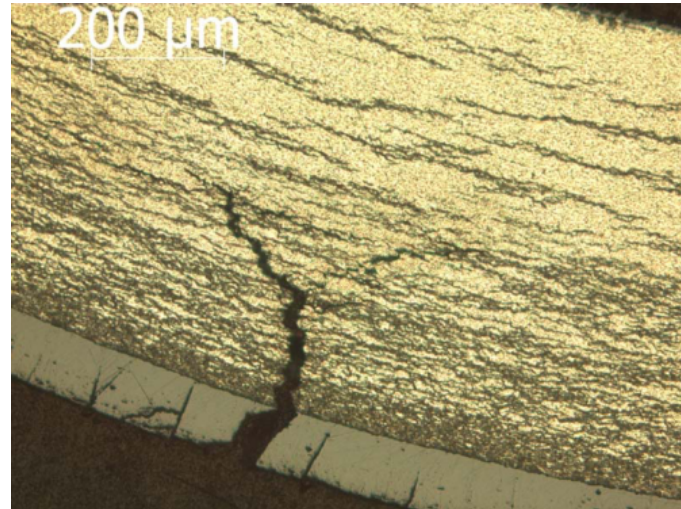
- Conduct ring compression tests on used fuel cladding
- HFIR cladding tests
- Conduct SS canister corrosion tests

Impact

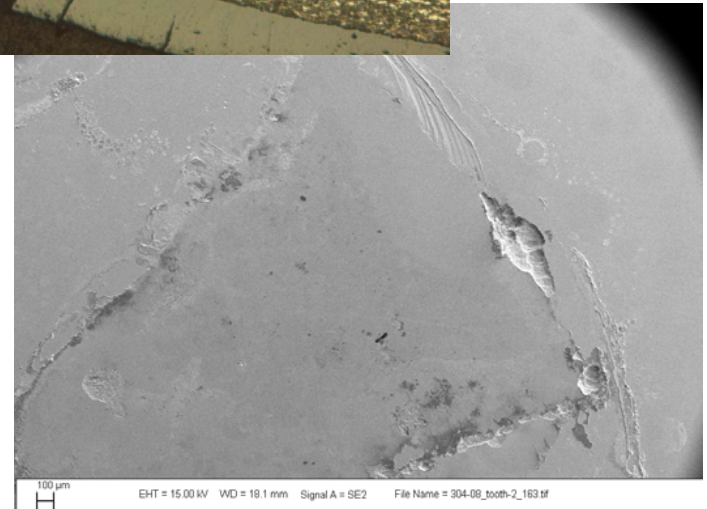
- This testing addresses high priority gaps identified for cladding and canisters

FY13

- Accelerate cladding and canister testing



Ring compression test on
HB Zry-4
Billone, Liu; ANL



304 SS 100 μ g/cm² corrosion test
Bryan, Enos; SNL



Engineering Analysis

Scope & Status

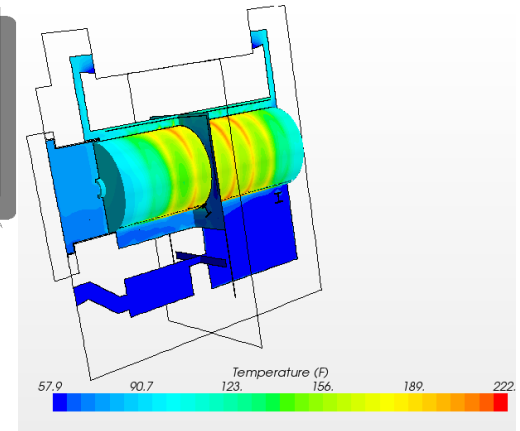
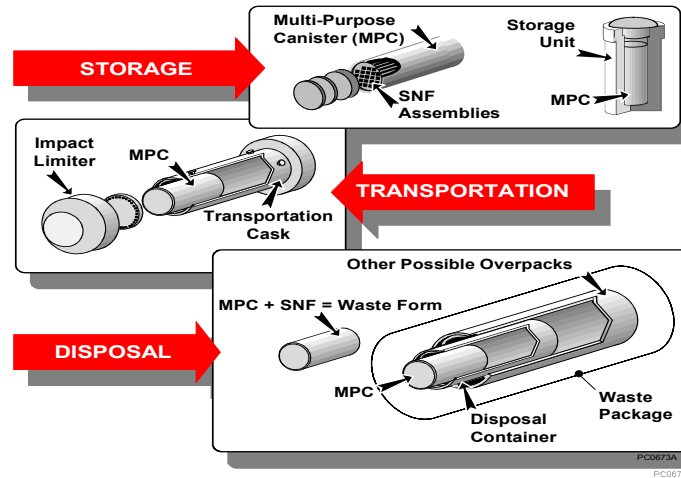
- Develop multi-purpose canister system concepts
- Conduct thermal analysis on Calvert Cliffs Canister
- Hydride re-orientation
- Support mechanical analysis of transport testing

Impact

- This testing addresses identified high priority gaps
 - Used fuel and canister thermal profiles (relates directly to canister corrosion issue)
 - Cladding integrity (focus on hydride development in cladding)

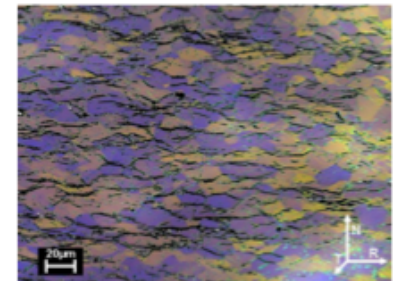
FY13

- Continue cladding and canister analysis
- Support transportation loading tests



NuHOMS thermal analysis
Adkins; PNNL

Preliminary hydride analysis
Tikare; SNL





Field Testing

Draft UFD test plan
Salt content sampler
Weiner; SNL

Scope & Status

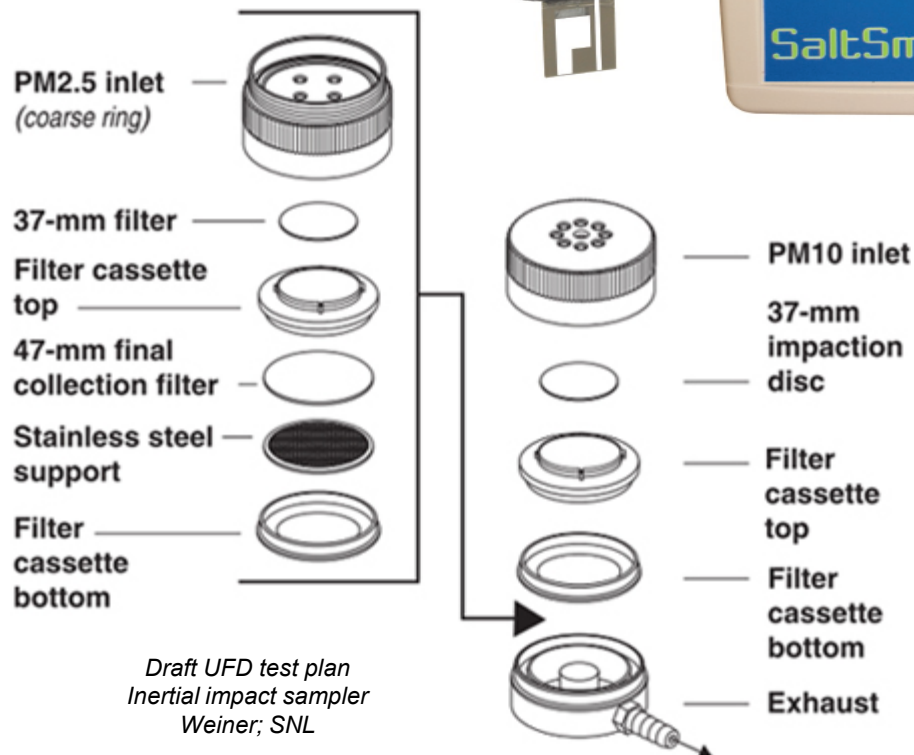
- Write Storage/Transportation RD&D Plan
(defines near-term separate effects testing needs based on gap analysis)
- Develop collaborative test plan with EPRI to assess on-site canister corrosion
(obtain in-situ atmospheric and canister performance data)

Impact

- The RD&D report supports readiness for the BRC recommendations.
- This testing addresses identified high priority gaps
 - Thermal profiles
 - Cladding integrity

FY13

- With EPRI and industry cooperation, expand canister corrosion testing to multiple ISFSI sites



Draft UFD test plan
Inertial impact sampler
Weiner; SNL



Transportation

Scope & Status

- Criticality analyses
(assess margin on k_{eff} for damaged fuel scenarios)
- Moderator exclusion
(concept development to assure moderator exclusion during transport accident events)
- Transportation test
(obtain data on realistic loadings transmitted to fuel during transport)

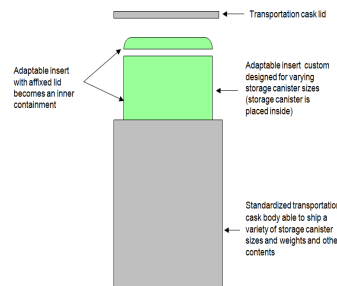
Impact

- Address alternate paths to transporting used fuel without the full suite of cladding data

FY13

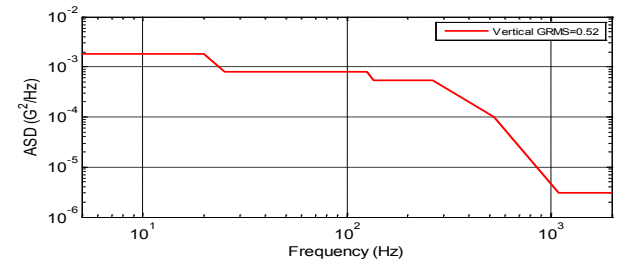
- Continue analyses and testing to support transport of HB used fuel
- Conduct data analysis to support planning for transport of fuel to support BRC recommendations

- Basic principle of defense-in-depth is the use of multiple barriers

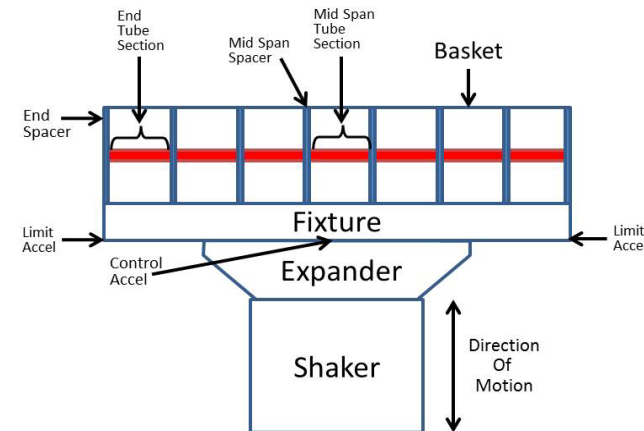


- Use of an inner containment depends upon the functionality of the storage canister

Moderator exclusion concept: INL



Assembly vibration analysis SNL



Vibration test frame concept: SNL



Conclusions

DOE/NE is supporting development of the technical basis for certification of very long term storage of used fuel and subsequent transportation. Programmatically, this includes:

- ***development of a plan to support experimental data gathering to address gaps in the existing data base,***
- ***conducting experiments to gather needed data,***
- ***working with the NRC to properly integrate data needs perceived by both the regulator and industry,***
- ***working closely with industry,***
- ***working closely with our international partners, and***
- ***development of the technical basis documents.***

Work aligns with recommendations published by the Blue Ribbon Commission

Extended Used Fuel Storage and Transportation Safety Basis

Industry Perspectives

**NRC Advisory Committee on Reactor Safeguards
Subcommittee on Radiation Protection & Nuclear Materials**

June 5, 2012

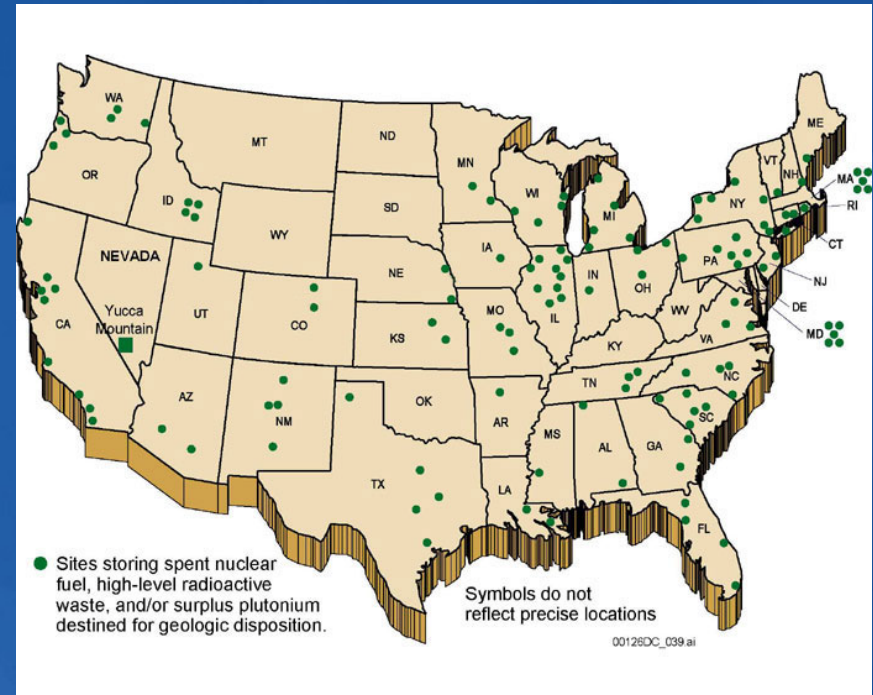
Rod McCullum



NUCLEAR
ENERGY
INSTITUTE

Used Nuclear Fuel in Storage

- **Used fuel inventory**
 - Approximately 67,500 MTU
 - Increases 2 - 2.4k MTU annually
- **ISFSI storage**
 - 64,610 assemblies
 - 18,100 MTU
 - 1,539 casks/modules loaded
 - 57 Operating ISFSIs
 - 1 pool ISFSI, 1 modular vault
- **Projections for 2020**
 - Estimating 88,000 MTU total
 - Estimating 31,000 MTU at ISFSI
 - 3,000 casks/modules loaded
 - At 76 ISFSIs
 - All plant sites + Morris & INEL
 - Fuel from 119 reactors



Historical Growth of Dry Cask Storage

DRY CASK STORAGE 1986 – 2011*

YEAR ENDING DECEMBER 31	NUMBER OF ISFSIs ADDED	TOTAL NUMBER OF ISFSIs	CASKS IN SERVICE	FUEL ASSEMBLIES IN DRY STORAGE
1986	-	2		
1987	0	2		
1988	0	2		
1989	0	2		
1990	1	3		
1991	0	3		
1992	1	4		
1993	2	6		
1994	0	6		
1995	2	8		
1996	1	9		
1997	0	9		
1998	1	10		
1999	1	11		
2000	3	14		
2001	3	17		
2002	6	23		
2003	4	27		
2004	1	28	664	22,644
2005	5	33	763	26,531
2006	3	36	848	30,032
2007	1	37	924	33,281
2008	8	45	1,073	40,280
2009	2	47	1,203	45,983
2010	5	52	1,351	52,381
2011	3	55	1,510	59,008

* Does not include fuel at Morris (wet ISFSI), Fort St. Vrain (modular vault), or INEL (TMI-2) .

Extended Storage Safety Basis

- **Dry Casks are robust systems with no moving parts**
- **Part 72.42 rulemaking increased license/renewal terms from 20 to 40 years**
 - “This increase is consistent with the NRC staff’s findings regarding the safety of spent fuel storage as documented in the renewal exemptions issued to the Surry and H.B. Robinson ISFSIs” 76 Fed. Reg. 8874 2/16/2011
- **Waste Confidence rulemaking**
 - “studies performed to date have not identified any major issues with long-term use of dry storage” 75 Fed. Reg. 81072, 12/23/2010
- **EPRI and NRC Dry Storage PRAs conducted in 2007**
 - Annual cancer risk between 1.8E-12 and 3.2E-14 *
- **Opportunities to further verify performance being pursued**

Performance Verification

- **INL Dry Storage Characterization Project opened cask stored from 1985 to 1999 and verified “long-term storage has not caused detectable degradation of the spent fuel cladding or the release of gaseous fission products”**
- **Industry working with DOE to develop a similar demonstration program for additional data (including higher burn up fuel)**
- **EPRI is conducting inspections to verify canister performance in chloride rich atmospheres**

Dry Storage and Transport Regulation

- **To be effective, regulatory process must**
 - Assure safety
 - Be risk informed
 - Incorporate experience of mature used fuel dry storage industry
 - Be consistent with NRC Principles of Good Regulation
 - Be implemented in a stable manner
- **As the process is faced with new challenges – e.g. extended storage – it must become more efficient**
- **Acknowledged need to improve regulatory framework**
 - COMSECY-10-007 approved “advancing the regulatory process improvement review to identify near term efficiency and effectiveness enhancements”
 - NRC Risk Management Task Force recommended staff identify and pursue “selected guidance and rule changes”

Regulatory Framework Improvements

Industry Priorities

- **Industry is interested in pursuing in the near term**
 - Defined/standardized format and content for CoCs
 - Criteria for what is included in Tech Specs and CoCs
 - Backfit protection for CoC holders
- **Industry has considered and decided not to pursue at this time**
 - Changes to the CoC Amendment process

Regulatory Framework Improvements

Longer Term Industry Priorities Relevant to Extended Storage

- **Retrievability**

- Rethinking 10 CFR 72.122(l) and 72.236(m) requirements for retrieval could reduce importance of long term cladding integrity for storage

- **Moderator Exclusion**

- Rethinking limitations on the use of moderator exclusion to demonstrate transportation safety in accordance with 10 CFR 71.55 could improve ability to assure transportability after periods of extended storage

- **Harmony Between Regulations**

- Establishing the regulatory platform for storage (wet and dry), transportation, recycling, and disposal as an integrated system

Extended Storage in an Integrated System

- **An integrated system must, at a minimum, connect the following elements***
 - **Storage at reactor sites**
 - **Transportation**
 - **Storage at consolidated sites**
 - **Transportation (?)**
 - **Disposal**
- **Integration must be built on the system we have, not the one we wish we had**

Past Efforts at Systems Integration Storage, Transportation, and Disposal Canisters

- **DOE Multi-Purpose Canister (MPC) System**
 - 1992, Feasibility Study
 - 1994, Design Specification
 - 1997, Funding/repository design uncertainties ended program
- **DOE/Industry Transportation Aging and Disposal (TAD) Canister System**
 - 2005, Proposal based on mature Yucca Mtn. repository design
 - 2007, Performance Specification
 - 2009, Vendor TAD license applications to NRC
 - 2010, Yucca Mtn. project terminated
- **Direct Disposal of Existing Dual Purpose Casks**
 - 2008, 3 NEI contentions in the Yucca Mountain licensing proceeding asserted disposability of already loaded dual purpose canister systems

Why direct dispose of already loaded canisters?

- **Maintain radiation exposure to workers As Low as Reasonably Achievable (ALARA)**
- **Avoid unnecessary costs**
- **Avoid interference with plant operations**
- **Avoid disposal of used canisters as low-level waste**
- **Overall risk reduction**
- **Alleviate need to assure retrievability after long-term storage**

Conclusion

- **There is a strong basis to support safe used fuel storage for extended time periods**
- **Industry is working pro-actively to address future challenges regarding extended storage**
- **Regulatory framework improvements will enhance our ability to address extended storage**
- **Extended storage should be addressed in the context of the integrated system in which it exists**