

Official Transcript of Proceedings
NUCLEAR REGULATORY COMMISSION

Title: Advisory Committee on Reactor Safeguards

Docket Number: (n/a)

Location: teleconference

Date: Thursday, October 6, 2002

Work Order No.: NRC-2113

Pages 1-75

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UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

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699TH MEETING

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
(ACRS)

+ + + + +

THURSDAY

OCTOBER 6, 2022

+ + + + +

The Advisory Committee met via hybrid
In-Person and Video-Teleconference, at 8:30 a.m. EDT,
Joy L. Rempe, Chairman, presiding.

COMMITTEE MEMBERS:

JOY L. REMPE, Chairman

WALTER L. KIRCHNER, Vice Chairman

DAVID A. PETTI, Member-at-Large

VICKI M. BIER, Member

VESNA B. DIMITRIJEVIC, Member

GREGORY H. HALNON, Member

JOSE MARCH-LEUBA, Member

MATTHEW W. SUNSERI, Member

ACRS CONSULTANT:

DENNIS BLEY

STEPHEN SCHULTZ

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1 DESIGNATED FEDERAL OFFICIAL:

2 MICHAEL SNODDERLY

3 DEREK WIDMAYER

4

5 ALSO PRESENT:

6 ELIJAH DICKSON, NRR

7 JEREMIAH DOYLE, NuScale

8 TYLER ELLIS, Public Participant

9 SID FOWLER, Public Participant

10 RAYMOND FURSTENAU, RES

11 MATTHEW HISER, RES

12 STEVE LYNCH, NRR

13 SCOTT MOORE, ACRS

14 JEFFREY POEHLER, RES

15 ANDREW PROFFITT, NRR

16 WILLIAM RECKLEY, NRR

17 MO SADOLLAH, RES

18 DIEGO SAENZ, Department of Homeland Security

19 MOHAMED SHAMS, NRR

20 MADHUMITA SIRCAR, RES

21 JOSEPH STAUDENMEIER, RES

22 GABE TAYLOR, RES

23 ROBERT TREGONING, RES

24 DUNCAN WHITE, NMSS

25

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C-O-N-T-E-N-T-S

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

(8:30 a.m.)

CHAIR REMPE: Good morning, this is the meeting. The meeting will now come to order. This is the second day of the 699th meeting of Advisory Committee on Reactor Safeguards. I'm Joy Rempe, chairman of the ACRS.

Other members in attendance are Vicki Bier, Vesna Dimitrijevic, Greg Halnon, Walt Kirchner, Jose March-Leuba, Dave Petti, and Matt Sunseri.

During today's meeting, the committee will first conduct its Planning and Procedures meeting at 1:30. The committee will be provided an information briefing by the Office of Research on harvesting materials, and after that time we will continue with our letter writing.

If we finish the P&P subcommittee, our full committee meeting early, we will also have some time to continue on our letter writing from yesterday.

The designated federal official for today's meeting is Larry Burkhart, and at this point we're going to go off the record, but I would like to ask the court reporter to return at 1:30 for our second topic. And so at this point, I'd like to ask Larry Burkhart, the designated federal official, to lead us

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1 through our Procedures and Planning meeting discussion.

2 MR. BURKHART: Okay. Thank you,
3 Chairman. I will start with --

4 (Whereupon, the above-entitled matter went
5 off the record at 8:31 a.m. and resumed at 1:30 p.m.)

6 CHAIR REMPE: Okay, I have that it's 1:30
7 on the East Coast here and I'd like to ask Matt Sunseri
8 to lead us through our next topic.

9 MEMBER SUNSERI: Thank you, Chair Rempe.

10 So my name's Matt Sunseri, I'm the ACRS lead member
11 for the engineering section of our periodic review of
12 the NRC Safety Research Program. We've asked staff
13 to be here today with us to have a informational briefing
14 updating us on activity since our last periodic review.

15 In that report, one of the items that we
16 identified was that we asked staff to consider if there
17 was any opportunity to add a quote, predictive modeling
18 capability to aging management strategies, along with
19 the current approach of establishing limits on life.

20 So they had a chance to look through the
21 material that will be presented today, and I think the
22 staff has information in there that touches on that
23 topic, so I'm happy to see, you know, that.

24 Without any further ado, I'd like to now
25 turn over to Ray Furstenau, the director of the Nuclear

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1 Regulatory Research Office. Ray?

2 MR. FURSTENAU: Yeah thanks, Mr. Sunseri,
3 and thanks, Chairman. Really on behalf of the Office
4 of Research, I really appreciate the committee having
5 these information briefings on specific topic areas.

6 As research director, I really find them
7 helpful to guide us in kind of bouncing off ideas on
8 our research program, and material harvesting is a big
9 one of course, and it takes time, it's expensive, and
10 you want to focus your resources where it makes the
11 most sense. So we appreciate this opportunity.

12 As you mentioned on the slides, there was
13 some background history of harvesting components and
14 our harvesting strategy, and how we prioritize the work
15 we're doing and are planning to do, and how we're
16 leveraging with other organizations like DOE and EPRI
17 to zero in on what makes the most sense.

18 You know, the timing is kind of good right
19 now. I think most of us hate to see perfectly good
20 plants maybe shutting down early or and
21 decommissioning, but it does provide us an opportunity
22 to focus in on these passive components that we would
23 like to get data on.

24 So it's a good opportunity to do that and
25 we're trying to take advantage of that, be selective,

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1 and with our partners and foreign as well as here in
2 the US to do that. And I think towards the presentation
3 we will go into a little bit more detail on the recent
4 and the current harvesting activities.

5 You know, although the NRC's had sufficient
6 confidence with our aging management programs we have
7 right now, and that has supported a license renewal,
8 testing of harvested materials on these passive
9 components really allows us to confirm that the existing
10 aging strategies in place were appropriate, and or we
11 adjust the strategies as needed because I think we would
12 all agree that effective aging management of
13 safety-related passive components is just essential
14 for safe operations.

15 So our activities are focused on issues
16 associated again with the safety significant component,
17 some passive components, of harvested material
18 research.

19 Again, you'll hear that it's prioritized
20 to attract conservatisms and uncertainties in the basis
21 of our existing guidance, and as with all regulatory's
22 research, it's kind of about uncertainties and
23 sensitivities, and when you look at uncertainties and
24 get data to reduce those uncertainties, you may find
25 out there's very conservatism and you have margin, or

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1 you may find out it isn't as conservative an issue as
2 you thought.

3 So all of this is all part of the strategy
4 that we have of the harvesting and examining harvesting
5 material. And again, it helps us look at aging
6 management strategies. Do they need to be
7 strengthened, do they need to be relaxed? And that's
8 kind of tied into the getting data to understand
9 uncertainties.

10 It also can support as we look into aging
11 beyond 80 years, you know, 60 to 80, but beyond 80 you
12 may have plans that might want to do that later on.
13 So I think that this all ties into that quite well,
14 so I'm kind of excited the group of folks that you have.

15 I'm going to get off of here, let the smart people
16 talk.

17 So I'm going to turn it over to Jeff Poehler
18 and Matt Hiser, and give up my chair to Rob Tregoning,
19 and I think they can answer any questions that come.

20 So again, thanks for the opportunity.

21 MEMBER SUNSERI: Before you sit down I'll
22 ask the members, any questions for Ray before he steps
23 down?

24 (No audible response.)

25 MEMBER SUNSERI: All right. Well, thanks

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1 for those opening remarks. Jeff?

2 MR. POEHLER: Can everyone hear me?

3 (Off-microphone comment.)

4 MEMBER SUNSERI: That's kind of a
5 directional, so if you can get that microphone pointed
6 right at your mouth? It's flexible so you can bend
7 it. Okay, all right.

8 MR. POEHLER: How's that?

9 (Simultaneous speaking.)

10 MR. POEHLER: How's that?

11 (Off-microphone comment.)

12 MR. POEHLER: Okay. Good afternoon. So
13 as Ray said, my name is Jeff Poehler, I'm a senior
14 materials engineer in the reactor engineering branch
15 in the Office of Research. And I'm supported today
16 in this presentation by Matthew Hiser and Rob Tregoning.

17 Matt is going to be presenting the second
18 half of the slides, and I kind of have to introduce
19 myself because I'm kind of new to the harvesting area.

20 I'm taking over Matt's role. Matt has really been
21 the lead and the subject matter expert in research on
22 harvesting for several years at least.

23 He's recently accepted a promotion to NRR
24 as a senior project manager in NRR Danyou [phonetic],
25 so I'm stepping in, but I'm certainly going to rely

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1 on Matt if there's any tough questions, and also Rob
2 Tregoning who's been heavily involved in harvesting
3 for quite some time.

4 He was our senior-level staff materials
5 engineering in the Division of Engineering and Office
6 of Research. With that to it, so this is what we're
7 going to be talking about today.

8 First we'll talk about background on
9 harvesting. We'll talk about the motivation and
10 strategy for harvesting, which includes the NRC's
11 harvesting priorities, we'll talk about the use of
12 previously harvested materials, we'll talk about
13 harvesting opportunities that the NRC staff is tracking
14 and looking at.

15 Then we'll talk about recent and current
16 activities in materials harvesting, and that includes
17 metals, concrete, components important to fire
18 research and electrical components. We'll touch on
19 outreach and partnership with other organizations, and
20 we'll end with conclusions and key messages.

21 So, oops, I skipped a slide.

22 So, harvesting background. So
23 historically, NRC industry and others have performed
24 research on materials harvested from a broad range of
25 components. And our current harvesting objectives

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1 focus on materials aging during long-term operation.

2 There are two basic objectives. One is
3 to confirm results from laboratory experiments and
4 simulations or models to prove understanding of aging
5 by testing materials aged in operating plants.

6 Secondly, to reduce uncertainty in the
7 current state of knowledge of aging and the
8 effectiveness, to enable informed NRC review of aging
9 management programs.

10 So what's the current situation with regard
11 to harvesting? Well, in the past harvesting efforts
12 have generally been reactive. You know, they were
13 limited to opportunities that arose, and that was
14 because there were few plants shutting down, that led
15 to more of a demand for, you know, harvesting materials,
16 and there was supply.

17 However, in recent years a significant
18 number of plants have shut down and entered the
19 decommissioning process. And so those plants have
20 generally operated for a long period, some, you know,
21 many more than 40 calendar years, which provides more
22 highly aged components for harvesting.

23 And currently we have more of a supply of
24 harvesting opportunities than in the past (audio
25 interference) advances. So therefore, the current

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1 situation calls for a more proactive, strategic
2 approach.

3 So, the NRC staff really began around 2015
4 began with an effort to develop the materials harvesting
5 strategy. Previously, we were very relatively
6 reactive to harvesting opportunities. In developing
7 this strategy there are a number of challenges.

8 First, harvesting is expensive, complex,
9 and time-consuming, particularly when involving
10 irradiated materials.

11 Second, documentation of component
12 fabrication and aging conditions is often difficult
13 and time-consuming. You know, generally, material
14 information is available. Sometimes it takes some
15 digging to get it.

16 Aging conditions, such as neutron fluence,
17 for example, you know, I'll give an example of reactor
18 internals components. Often, there are not detailed
19 fluence maps of internals readily available. They can
20 be generated but they're not always available, so that
21 can be a challenge. Also operating temperature.

22 MEMBER MARCH-LEUBA: Willing to help you
23 all. What's the proportion of the job and the
24 documenting the condition of the way it has operated?
25 Does it drive you towards sampling other things that

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1 you can may -- if you have two -- option A, option B,
2 you have a good map of the (audio interference) A doesn't
3 cover it, but A may have some more value. Do you --
4 how can you weigh that?

5 MR. POEHLER: Well, I think we would
6 probably go with the harvesting the material that's
7 more value to us, or higher priority. I'm going to
8 talk about the priorities.

9 (Simultaneous speaking.)

10 MR. POEHLER: You know, usually, you know,
11 things like a fluence map, for example, can be
12 generated. This costs us money, so. You know, I think
13 if we had an idea that this was a high priority material
14 to harvest, we would try to make that happen.

15 MEMBER MARCH-LEUBA: And would you
16 consider like something more than you can analyze, and
17 save it in a hold somewhere?

18 MR. POEHLER: Yeah, I mean, that is an
19 option too, to harvest materials and not test them until
20 later, you know, to archive materials.

21 MEMBER MARCH-LEUBA: Do you do that
22 because now we have an opportunity to collect (audio
23 interference) and just from my point of view --

24 MR. POEHLER: And sometimes we do that just
25 because we don't necessarily have the budget to test

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1 some of aging stuff. But yeah, there are definitely
2 archived (audio interference) existing, and that is
3 definitely an option to do.

4 MEMBER HALNON: So, going further, do you
5 take samples out of decommissioned sites and put them
6 back into like a coupon sample into existing to get
7 a higher fluence?

8 MR. POEHLER: Yeah, I mean that can be
9 done, that's something that can be done, and has been
10 done, you know, to take something that's irradiated
11 and let's say put it in a test reactor and irradiate
12 it more, to get higher results.

13 MR. HISER: Can I just add --

14 MR. POEHLER: Go ahead.

15 MR. HISER: And I apologize. I'm just
16 wearing a mask, I kind of lost my voice yesterday, I
17 don't think I'm contagious, I don't feel sick at all,
18 but just wanted to set everyone at ease.

19 I just wanted to get back to the initial
20 question and just shed a little more light. I think
21 related to the documentation issue, it really comes
22 into identifying and choosing between opportunities
23 just like you were suggesting.

24 And so that becomes a challenge, is
25 knowing, having a good understanding of what is the

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1 fabrication and the aging conditions, planned
2 components at different plants, if meaningfully
3 distinguished?

4 Because, you know, it may cost half a
5 million dollars, \$1,000,000 to do a really detailed
6 fluence analysis and know what's the exact fluence
7 levels for your plant.

8 We can't go do that at ten different plants
9 and then say which one do we want? You know, that's
10 just impractical.

11 So we kind of have to use the information
12 we do have through designs, through industry-wide, you
13 know, how long did a plant operate, what do we understand
14 about that design?

15 Make informed decisions, then once we
16 choose to jump on an opportunity, see if we're going
17 to pursue it, ideally with partners, maybe DOE, EPRI,
18 international organizations, then we may need to
19 invest, you know, in the course of implementing that
20 project, we may need to spend collectively the group,
21 whatever it takes to, you know, sufficiently analyze
22 them so when we get results we know we're looking at
23 20 DPA material, not 10 DPA material, for instance.

24 Hopefully that kind of helps give a little
25 bit more.

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1 MR. HISER: Yeah, that seemed to do it.

2 MR. POEHLER: And I think we'll get on to
3 it. Okay?

4 MEMBER SUNSERI: Yeah, no, that's a good
5 summary of the next ten slides, but why don't we just
6 go ahead and move on?

7 MR. TREGONING: Well, I think it's
8 important -- Rob Tregoning from the staff -- I did want
9 to clarify Chairman Allen's question. So Jeff answered
10 it correctly, there are instances where we pull
11 materials out and machine them out, and then put them
12 in test reactors.

13 The other thing that we do, the one area
14 of harvesting which is actually required in the
15 regulations, is surveillance testing, and we've done
16 that since the plants were built, right, and that's
17 how we monitor reactor pressure vessel and (audio
18 interference).

19 So you'll see today that we don't talk
20 anything about the surveillance program, so when we
21 talk about harvesting, we're not talking about the
22 surveillance program.

23 Surveillance program they exactly do that
24 as well, they have a very coordinated plan that they've
25 developed that we review and approve, and they make

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1 sure that they have coverage in terms of the conditions
2 that they need to sample and understand out in the fleet.
3 It goes from a fluence perspective, but then also a
4 chemistry perspective.

5 So it's very, you know, precise and
6 regimented in the surveillance program. We won't talk
7 about that here, but we certainly do similar strategies
8 with materials that we have if we want to examine
9 extended conditions as well.

10 MEMBER HALNON: Yeah thanks, and this is
11 Greg. The point of my question was that connection
12 because I know that we're running out of surveillance
13 specimens for the higher fluences so if you take, you
14 know, a shut down plant that's exceeded it, and the
15 way of extending that, we'll put more materials in.

16 So I was just wondering about that
17 connection between you and the surveillance program,
18 but I realize that, you know, it's all the same
19 materials, people are looking at the same stuff. So,
20 I understand.

21 MR. POEHLER: And then the third challenge
22 is, you know, the decommissioning versus harvesting.

23 So, you know, a decommissioning company
24 trying to decommission a plant has a different objective
25 than a person that wants to harvest materials, and

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1 sometimes those two things sort of conflict because
2 the decommissioning schedules are often, you know, very
3 tight and you have to fit harvesting in, and it
4 definitely would impact decommissioning activities
5 schedule, and also, you know, the storing and
6 transporting of harvest materials can add to an already
7 complicated process.

8 So you know, because of all these
9 challenges, the NRC staff is just, you know, basically
10 trying to focus on high value harvesting opportunities.

11 And also to seek cooperation and collaboration when
12 possible to maximize limited NRC resources.

13 Now I'm going to talk about the elements
14 of the NRC's proactive harvesting strategy. So the
15 first element is to identify and prioritize harvesting
16 interests. That process is going to focus on the unique
17 value of harvesting relative to other sources of
18 information, such as accelerated aging in a laboratory
19 or test reactor, and use of operating experience.

20 The second element would be considered use
21 of previously harvested materials when possible.
22 That, you know, has greatly reduced cost, time, and
23 complexity compared to new harvesting, however it's
24 limited in the range of materials in aging conditions
25 that are available.

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1 And the third element is to gather
2 information on harvesting opportunities. That
3 requires sufficient information to be equally
4 comparative priorities, but it's kind of like, you know,
5 what we talked about, making the best decisions with
6 the information we have, such as operating conditions
7 and things like that.

8 And then it's also challenging to acquire
9 that information across the population of
10 decommissioning plants. You know, you generally need
11 to have the cooperation of, you know, the owner and
12 other industry groups to help get that information,
13 and it's a lot of legwork.

14 Next I'm going to talk about the technical
15 prioritization criteria that the NRC staff applies in
16 our strategy. The first one is the criticalness of
17 the technical issue addressed. So, they're high safety
18 -- I don't know why I (audio interference) --

19 MR. FURSTENAU: (audio interference) When
20 he talks too long, I think it --

21 (Simultaneous speaking.)

22 MR. POEHLER: Could be, yeah. Clearly,
23 I guess PowerPoint's trying to send me a message. But
24 --

25 (Simultaneous speaking.)

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1 (Laughter.)

2 MR. POEHLER: So, higher safety
3 significance components and with less available data
4 would leave to a higher ranking for that type of
5 component.

6 Second criteria is the importance of
7 harvested material over laboratory aging, so in plant
8 aging conditions or materials that are more difficult
9 to replicate at the lab leads to a higher ranking.
10 You know, for example, let's do the combination of
11 thermal aging and irradiation for cast austenitic
12 stainless steels, it's hard to replicate in the lab.

13 And then the third criteria is
14 applicability to the U.S. operating fleet. So, the
15 more plants in the fleet that a particular issue is
16 applicable to, would lead to a higher ranking.

17 And fourth, regulatory considerations
18 related to inspections in aging management programs.

19 So greater availability and confidence in inspection
20 methods or aging management approaches leads to a lower
21 ranking, so if you have a component that has a robust
22 inspection program or condition monitoring program that
23 gathers a lot of data regularly, versus a component
24 where you really have difficulty inspecting it, like
25 certain parts of the reactor internals and things like

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1 that are difficult to inspect.

2 MR. HISER: Jeff, may I go? Can I --

3 MR. POEHLER: So --

4 MR. HISER: Can I --

5 MR. POEHLER: Yeah, go ahead, Matt.

6 MR. HISER: Yeah, so I was going to say,
7 so an example for instance -- one example of a very
8 inspectable component is the --

9 (Audio interference.)

10 MR. HISER: Oh, sorry.

11 (Audio interference.)

12 MR. HISER: Okay. Thanks, Steve. Matt
13 Hiser. Just an example of one that's easily inspected,
14 baffle bolts, for instance.

15 The industry does, and has committed to
16 doing 100 percent inspections on baffle bolts as they
17 enter the extended operation period, so you know, while
18 baffle bolts may be -- they are a relatively low safety
19 significant component, but they also -- from the
20 standpoint of this criteria, we wouldn't really be as
21 focused on them for harvesting because we consider them
22 to be handled by a very robust aging management
23 inspection program.

24 Conversely, something that may have to do
25 with embrittlement or loss of toughness, very

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1 difficult, you know, or not at all possible to inspect.

2 Those may be the types of issues that on safety
3 significant components, we would focus more on for
4 harvesting. And I apologize for my voice.

5 CHAIR REMPE: I have a --

6 (Simultaneous speaking.)

7 CHAIR REMPE: Well, okay. I apologize if
8 you've already said this, but this is something that
9 just the NRC staff uses for your prioritization, or
10 do you ever include other experts that are in the fields?

11 I'm glad to hear you consider what else is going on
12 in the field, but this is just an internal research
13 organization that is doing the ranking?

14 MR. HISER: Yeah, I mean, well, I mean,
15 within the NRC, we research a week, coordinate with
16 our stakeholders and the program offices, particularly
17 NRR, but also, you know, we also collaborate with other
18 parties and organizations, such as EPRI and DOE.

19 CHAIR REMPE: Oh, you show your rankings
20 and then if --

21 MR. HISER: Oh --

22 CHAIR REMPE: We said oh no, but you
23 forgot, you might change them, or how does that work?

24 MR. HISER: Yeah, correct me if I'm wrong,
25 Matt, but with EPRI we do kind of come up with joint

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1 rankings.

2 MEMBER SUNSERI: Yeah. I'll circle back
3 on the first part of your question too, Dr. Rempe.
4 So, we about three years ago sort of went through these
5 criteria internally, staff and NRR and research and
6 the materials area, with knowledge in of specific
7 components and aging conditions, went through and they
8 spent, you know, several lengthy meetings looking
9 through tables identifying interests and then
10 prioritizing them through these criteria.

11 So we sort of established internal agency
12 priorities. We then have carried those priorities into
13 discussions. We've had a couple workshops, including
14 international parties. We've also have regular
15 coordination with DOE lab staff and EPRI, and we have
16 had some opportunities to share and exchange views on
17 priorities.

18 There are similarities, you know, not 100
19 percent, line up with maybe where NRC's high priorities
20 are and EPRI's or DOE's. But we have done that, but
21 this criteria, or NRC's criteria that we have used for
22 internal, you know, discussion in identifying our
23 priorities. And we have identified that we're planning
24 to update these.

25 We haven't really done an update in about

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1 two or three years, we sort of implicitly do, but we're
2 not going to do a rigorous update. We'll probably do
3 that sometime in the next couple years.

4 CHAIR REMPE: That helps, thank you.

5 VICE CHAIR KIRCHNER: I was just going to
6 ask you a question at a higher level, going back to
7 Ray's introduction, I would presume by now (audio
8 interference) all the other work you've done and what
9 you're getting from your inspectors in the fields on
10 (audio interference), it seemed to be you would start
11 at a component or a higher level and then say okay,
12 of these components, these are critical to safety
13 considerations in the fleet, these we have a lot of
14 confidence on, others we don't, we now have the property
15 -- the material properties degrade or don't with age,
16 corrosion, radiation, whatever.

17 Is there some higher level, you know,
18 starting point that you're using to -- and then, I
19 understand your criteria and such. Have you -- based
20 on the experience you collectively have, do you have
21 a few targets of opportunity that are high on your list
22 or?

23 (No audible response.)

24 VICE CHAIR KIRCHNER: So you see where I'm
25 going with this?

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1 MR. HISER: Yeah, I understand.

2 VICE CHAIR KIRCHNER: And then what these
3 really -- do you have good models, or I'll make something
4 up for radiation influence on stainless steel --

5 (Audio interference.)

6 VICE CHAIR KIRCHNER: Sorry, yeah, this
7 is Walt Kirchner and I was asking Matthew's team about
8 at a higher level, have you identified targets of
9 opportunity that where you go through this, you'll
10 really see high pay off?

11 MR. HISER: Yeah sorry, so I think that
12 specifically what our high priorities -- we have a slide
13 -- I think in a few slides -- that covers exactly sort
14 of some of the specific high priorities that came out,
15 but to your higher level question, in terms of rolling
16 in things like GALL and PMDA and EMDA that sort of inform
17 aging management, what we were trying to focus on here
18 is where this harvesting meaningfully add new
19 information?

20 And like that second bullet on importance
21 of harvesting materials over laboratory aging, that's
22 something that we come back to, that's something that's
23 inspected or there's a lot of operating experience,
24 or it's easy -- take the PWSCC issue, right? There's
25 been a ton of crowd growth rate testing done on PWSCC.

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1 And that doesn't mean we would not
2 consider, you know, looking at harvesting something
3 to confirm some of that with some actual plant aged
4 materials, but that would be a consideration if that's
5 a phenomenon that we feel like has been investigated
6 heavily, a lot of inspection footprint in the aging
7 management, you know, for susceptible materials.

8 But I would say a lot of that was brought
9 in with the knowledge of the staff and the provision
10 of, you know, license renewal and NRR, and then staff
11 and research that have been involved with developing
12 the GALL, the EMDA and PMDA reports over the last, you
13 know, 15, 20 years.

14 We sort of -- I don't know that we
15 explicitly sort of, you know, wrote down, but we were
16 building off that legacy and then looking at, how can
17 we -- what's the facet that harvesting can help us be
18 smarter, you know, fill areas where we'd like to have
19 a little more knowledge, a little less uncertainty.
20 Maybe that's helpful.

21 VICE CHAIR KIRCHNER: Yeah. You're
22 basically telling me you're using your corporate
23 knowledge and you know where these opportunities are,
24 here's the priority for sorting through --

25 MR. HISER: And when I say we I don't mean me,

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1 or even me, Jeff, and Rob, but you know, 20 or 30
2 extremely knowledgeable and experienced staff across
3 the agency.

4 VICE CHAIR KIRCHNER: Well, maybe a little
5 bit more specific question along those lines. Do you
6 from a technical prioritization you looked for --
7 there's many more sophisticated models and a variety
8 of areas these days that could probably be I'll call
9 it calibrated to real plant data?

10 Do you look for those kind of opportunities
11 where say, this predictive tool could be so much better
12 if we could calibrate it to, you know, real plant data
13 versus, you know, aged in a lab data or whatever? Is
14 that input to your somehow?

15 MR. POEHLER: Yeah, I mean, kind of. I
16 mean, sometimes, you know, for example, we had -- there
17 was a ASME code case on prior growth rates for irradiated
18 stainless steels due to radiation, such as stress
19 corrosion cracking. So there was, you know, a model
20 there based on data that was available.

21 So that was based on real data, but then
22 you obtain more data through harvesting that showed
23 that those traits were potentially non-conservative.

24 So --

25 VICE CHAIR KIRCHNER: Well maybe we'll get

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1 to it later. I'm thinking like the concrete stuff,
2 which like a good area where you could get out in front
3 of some of the concrete issues that we have, you know,
4 calibrating--

5 MR. POEHLER: You'll see that. That's --
6 (Simultaneous speaking.)

7 MR. POEHLER: Sorry. That's an important
8 part of our strategy, right? We're always trying to
9 -- because we have models for just about every
10 phenomenon, so we're always trying to test the limits
11 of those models and their applicability as we go to
12 higher and higher regimes that we're going to see later
13 and later in life. So that's a fundamental
14 consideration for all of the choices that we make.

15 MR. STAUDENMEIER: I was going to add, you
16 know, some of those models -- and Jeff was mentioning
17 one based on empirical data, others are first principle
18 models, and you're looking to, you know, harvesting
19 could help to, whether it's extending the window that
20 we sort of have verified, validated it, or established
21 in any window where it's really has some, you know,
22 relevant data. So yeah, we look for those
23 opportunities.

24 MR. POEHLER: Okay. So this slide
25 discusses our high priorities for metals, so there are

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1 basically four, so the first one is Alloy 600
2 thermally-treated steam generator tubes with shallow
3 flaws. So the purpose of the --

4 MEMBER MARCH-LEUBA: Yeah, I'm confused.
5 Alloy 600 or 600 tubes?

6 MR. POEHLER: Tubes. But specifically,
7 thermally-treated.

8 MEMBER MARCH-LEUBA: Not a quantity of 600.

9 MR. POEHLER: Alloy 600 is the end.

10 MEMBER MARCH-LEUBA: It really would be
11 complicated with 600 tubes.

12 MR. POEHLER: No.

13 MR. HISER: No, alloy.

14 MR. POEHLER: No. Yeah, we're falling
15 into nomenclature. We left the word alloy off in front
16 of that to save space.

17
18 But yeah, so you know, the purpose of this
19 testing would be to do NDE and mechanical testing to
20 establish structural integrity. Technical knowledge
21 to gain would be, you know, an assessment of basically
22 the accuracy of the ND that's performed in the field,
23 and also, you know, to how much structural integrity
24 is left in those tubes that have shallow flaws.

25 The status is we're seeking opportunities

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1 to harvest these type of tubes.

2 The next one is thermally-aged
3 unirradiated cast stainless steel or casts, cast
4 austenitic stainless steel. We want that for fracture
5 toughness testing and microstructural testing.
6 Technical knowledge we would like to gain is basically
7 fractured toughness from real plant-aging conditions
8 to compare it to accelerated aging data.

9 You know, there's data generated at higher
10 temperatures than actual plant operating temperatures
11 on thermal aging, and we try to, you know, create an
12 equivalency to, you know, the temperature you would
13 see in a plant. The status were we have identified
14 and we're pursuing an opportunity for that.

15 The next one is the bottom mounted
16 instrumentation or BMI nozzles with known primary wood
17 or stress corrosion cracking indications. We would
18 like to obtain those for residual stress measurements
19 and also crack initiation and growth testing, and also
20 flaw characterization.

21 The knowledge we'd like to gain is to
22 confirm the adequacy of current inspection requirements
23 and confirm the NDE effectiveness of flaw
24 distribution. We're currently seeking opportunities.

25 There are few plants with known BMI indications.

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1 And finally, prior fluence stainless steel
2 welds, and those are welds that have greater than two
3 DPA of neutron exposure. We want those to test for
4 fracture toughness, radiation assisted stress,
5 corrosion, cracking growth rates, and microstructural
6 characterization. The knowledge we'd like to gain
7 there is properties to inform inspection scope and
8 interval, and also flaw evaluation criteria.

9 (Simultaneous speaking.)

10 MR. POEHLER: Yeah. Okay. I know we are
11 looking at obtaining those materials through the SMILE
12 program, which I am going to talk about on a subsequent
13 slide, and some other opportunities.

14 CHAIR REMPE: I'd like to explore the one
15 about the bottom-mounted instrumentation nozzles. Is
16 the primary -- stainless steel and Inconel, or just
17 the stainless steel is what you're looking at that you
18 find on PWRs or the PWRs?

19 MR. POEHLER: Yeah, no, I think we're
20 looking more at PWRs that have Alloy 600 penetrations
21 and well, alloy 82, 182 welds. There's been some
22 operating experience with --

23 CHAIR REMPE: Does it matter?

24 (Simultaneous speaking.)

25 CHAIR REMPE: I mean, the different

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1 designs Westinghouse had different than B and W and
2 is it just the Westinghouse ones, or?

3 MR. POEHLER: I --

4 CHAIR REMPE: Or CE ones?

5 MR. POEHLER: Yeah, no. I'm not sure.
6 It's probably Westinghouse designs. I don't know,
7 maybe Matt or Rob can come out then?

8 MR. TREGONING: I was going to say, I think
9 the real narrowing factor here is known PW 60 occasions.
10 I think there's maybe one, two plants.

11 CHAIR REMPE: Yeah.

12 MR. TREGONING: For which that's through,
13 and those plants are continuing to operate. They've
14 done repairs. So this is something that, you know,
15 would be applicable to all operating PWRs which have
16 Alloy 600, you know, and it's basically an analogous
17 situation to the upperhead, just a lower temperature.

18 So the presumption is it'll take longer
19 for the cracks to initiate, but the safety significance
20 is potentially high, and there has been some operating
21 experience.

22 You know, if one of those plants shut down
23 for instance, then at these indications, we would
24 certainly be, you know, interested in pursuing trying
25 to do some harvesting to get better knowledge about

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1 that to inform, you know, aging management (audio
2 interference).

3 CHAIR REMPE: Thank you.

4 MR. POEHLER: So the next slide is similar
5 to the previous one but covering concrete and structural
6 and electrical high priorities.

7 The first one there is irradiated concrete.

8 You can see there's a lot of different testing that
9 we would like to do on that, and that includes in-situ
10 and in-service data for model verification, in-situ
11 NDE mechanical and microstructural properties
12 characterization, bench marking of structural damage,
13 and the potential, you know, for further irradiating
14 these materials.

15 The knowledge we'd like to gain there is
16 to, you know, reduce the uncertainties in models,
17 evaluating rate effects of in-service conditions versus
18 accelerating radiation, size effects. That is real
19 structures versus test specimens and a test reactor.

20 Evaluating concrete radiation and damage, depth,
21 gradiance and concrete bioshield, and to inform
22 structural integrity evaluation and inspection.

23 And we have identified and are actively
24 pursuing an opportunity to obtain irradiated concrete.

25 The next one here is reactor supports.

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1 So we're interested in testing embrittlement, fracture
2 toughness and microstructural characterization. We'd
3 like to gain knowledge on structural integrity and
4 performance and inform inspection scope.

5 We have identified and are pursuing an
6 opportunity to obtain reactor support materials.

7 Then the last one is electrical cables,
8 both low and medium voltage. So we'd like to test to
9 compare service-aged specimens with accelerated age
10 specimens, and assess the effectiveness. Also to
11 assess fire spread and thermal failure criteria.

12 The knowledge we'd like to gain is the
13 confirmation of the technical basis for aging
14 management programs. We are currently seeking
15 opportunities to harvest cables.

16 MEMBER HALNON: This is Greg. Are you
17 looking exclusively for the cables at nuclear plants
18 or are you going to old fossil plants and other places
19 that may have similar aging issues?

20 MR. POEHLER: Nuclear, I believe. I think
21 we have -- some already done some. Do we have some
22 tech cable testing that we've done already?

23 (Simultaneous speaking.)

24 MR. TREGONING: I was going to make a note
25 on that.

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1 I think the seeking opportunities is less
2 that it's hard to find them or we're struggling, but
3 maybe some of the other ones it's more, you know,
4 research programs require an area that, and in the
5 Division of Engineering area that are already ongoing,
6 and sort of we have an aspiration to get more, but we
7 don't necessarily have our research, you know, we're
8 not ready to go get them right now, they're more for
9 our research needs than it's so hard to find electrical
10 cables, you know, decommissioned.

11 MR. FURSTENAU: Yeah, it's Ray Furstenau.

12 And I was going to say because I mean, there's a lot
13 of old fossil plants that aren't being used right now,
14 50, 60, 70, sometimes 80, 90 years old, so.

15 MR. TREGONING: Yeah. We have a slide
16 coming up that talks about sort of what we've done and
17 we have harvested cables before. The other comment
18 I just wanted to make on the priorities overall is just
19 kind of harping back to what Rob's point was earlier,
20 that you'll notice that these are just our high
21 priorities, there are, you know, medium and low
22 priorities.

23 But you'll notice there are no RPV, reactor
24 pressure vessel components on here, and it's for the
25 exact reason Rob was mentioning, the surveillance

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1 program.

2 There's just a much greater level of
3 knowledge of those materials, obviously their safety
4 standards is very high. But we felt like the unique
5 contribution for harvesting is it's harder to sell and
6 justify it, so on that, particularly on a couple of
7 those criteria, any RPV materials end up being
8 downgraded so they just don't end up bubbling up to
9 the very top. I just wanted to kind of make that higher
10 level point.

11 MR. POEHLER: Now I am going to touch
12 briefly on previously harvested materials, so the NRC
13 staff have catalogued the previously harvested
14 materials from prior NRC sponsored research. That
15 includes at PNNL we have a large array of components
16 penetrations up to large piping sections, so we're using
17 NDE research.

18 Battelle, we have some large primary system
19 piping in all those, and Argonne National Lab we have
20 smaller reactor internals materials, irradiated
21 reactor materials.

22 Some of the other sources of previously
23 harvested materials are the Department of Energy
24 Nuclear Fuels and Materials Library. Also Studsvik
25 with the SMILE related and other harvested materials.

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1 And also the Halden Reactor Project.

2 This is basically showing a little snippet
3 of the column headings from the joint harvesting
4 opportunities table that NRC has worked with EPRI to
5 develop. It covers both domestic and international
6 harvesting opportunities for both plants that are
7 decommissioning now or have announced shutdown dates.

8 And this is just providing examples of the headings
9 for the columns and what types of information.

10 So in addition to all the basic plant
11 information and operating conditions, you have for the
12 various components, you know, specifically, you know,
13 materials, environment, in terms of fluence,
14 temperature, and water chemistry. You have that for
15 each type of component, and these are some of the ones
16 obviously they were interested in the RPV, although
17 I'll just mention that we're less interested in that
18 in general.

19 RPV had penetrations and its baffle plates
20 internals bolts and of course shroud and barrel welds,
21 so these are just examples. There's more, different
22 categories of components in the table.

23 MR. TREGONING: Okay. Can I ask --

24 MR. POEHLER: Go ahead.

25 MR. TREGONING: Yeah, we had a question

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1 earlier about documentation.

2 So this table was really developed, or
3 we're developing it because it's a living table in
4 conjunction with industry, try to not only identify
5 the plant, the characteristics of the plants and
6 materials that are out there now so we understand their
7 attributes, but also to make the plant owners aware,
8 hey, this is the information that we want from a
9 harvesting perspective, because I think what we found
10 when they go into decommissioning, a lot of times it's
11 the documentation that's the first thing that's
12 disposed of.

13 So, getting that documentation, getting
14 knowledge from the decommissioning companies and plant
15 licensees of the types of information that we want,
16 we tried to distill it down for this spreadsheet table
17 that we've got so that we can be more sort of reactive
18 when we find out a plant's closing down. You know,
19 if we want to identify if there are any opportunities
20 we could go to the licensee of the decommissioning
21 company and say here are the things that we would like
22 to understand if you have this information.

23 MR. HISER: Yeah, and I'll just add from
24 a little more of a practical note, we have not had as
25 much success being able to populate this spreadsheet.

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1 I think in an ideal world for every plant in the U.S.
2 and even internationally, you know, we'd like to have
3 as much of these columns out, and then we could sort
4 of look at dates, look at logistics, you know, and also
5 most importantly, look at where our priorities and which
6 one would best address it.

7 In practice it's hard to get all of this
8 information even for one plant. It requires a lot of
9 digging into records that we don't have access to
10 necessarily. You know, you can get some from an FSR
11 but you're not going to get all of this, especially
12 on the environmental conditions, DPAs, temperatures,
13 for specific components.

14 So we've not had as much success but EPRI
15 has continued to kind of push on industry, make this
16 a priority with them. In fact, just in the last I'd
17 say six months to a year, they said they're going to
18 continue trying to press their members to provide input.

19 We got a lot of information actually from
20 the Swedish plants that are involved in the SMILE
21 project because they're doing a lot of harvesting and
22 they dug up a lot of that information.

23 But we do think this is a good tool. We
24 haven't been able to maybe make it as effective as we
25 hoped because we're lacking the ability to populate

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1 it as well as we can but I think it's a good framework
2 that hopefully we can build on and populate over time.

3 CHAIR REMPE: How willing are the
4 decommissioning companies to provide the information?

5 Because you said that's one of the first things they
6 destroy. Are they willing to share?

7 MR. TREGONING: It depends on the
8 decommissioning company. And I think Matt talked
9 earlier, this is not their prime business objective.

10 And so finding a willing partner that is engaged in
11 harvesting, that's a very difficult challenge.

12 And I would also just add it depends how
13 the decommissioning's progressing. You know, some of
14 these plants, the utility that operated the plant is
15 just selling the plant.

16 CHAIR REMPE: Right.

17 MR. TREGONING: You know, Palisades, for
18 instance, Holtec, do not operate the plant, they bought
19 the plant from Entergy. Now they're trying to see if
20 they can restart it, but, you know, Holtec's not really
21 in the business of operating nuclear plants, they're
22 in the business of really nuclear waste canisters, and
23 you know, doing other parts of the nuclear business.

24 But, so, you know, or energy solutions,
25 for instance, is really just decommissioning. So, it

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1 gets handed off. We really don't have knowledge of
2 that decommissioning company to really operate a plant,
3 and all of this is really operating plant kind of stuff.

4 CHAIR REMPE: So when you said it's
5 destroyed, my mind immediately thought that Holtec or
6 some company like them would be the ones that would
7 be first to destroy it. What you're saying is actually
8 the plant before they sell to the decommissioning
9 company might destroy it?

10 MR. TREGONING: And maybe destroy it. Let
11 me amend my remarks. Maybe destroy is too strong a
12 word there. It becomes unavailable for a variety of
13 reasons.

14 CHAIR REMPE: From the plant
15 owner/operator, not the decommissioning company?
16 Because that's what I thought, oh, the decommissioning
17 company --

18 MR. TREGONING: Right. And -- well, but
19 if the decommissioning company comes in and there's
20 no plant people that are still working, the
21 decommissioning company has no idea where to find that
22 information.

23 MR. FURSTENAU: Yeah, it was not
24 maintained.

25 CHAIR REMPE: But you got to catch it, and

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1 it's --

2 MR. TREGONING: And it depends on the plant
3 because some plants, Westinghouse archives a lot of
4 that information. So then you have to go back to
5 Westinghouse to try to get it, and/or whoever the
6 original vendor was, and that can be challenging as
7 well because even though it's technically available,
8 finding it can be a bit of an archaeological challenge.

9 MR. FURSTENAU: Or it depends on the
10 component and how the internals, typically all the
11 fabrication records weren't handed over to the plant
12 to the internals. And the vessel, they would've been.
13 You know, so if you're trying to harvest internals,
14 you're probably back at the vendor, Westinghouse CE,
15 digging into their records, and yeah.

16 MR. TREGONING: It's totally a potpourri.

17 MR. FURSTENAU: Yeah, it just varies.

18 (Simultaneous speaking.)

19 MR. TREGONING: The plant --

20 (Simultaneous speaking.)

21 MR. TREGONING: Yeah, and where you come
22 from the decommissioning process.

23 MEMBER SUNSERI: Not to belabor the
24 discussion but I think of it coming down to these are
25 all construction records that are required to be

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1 maintained for the life of these facilities, so what's
2 the definition of life of the facility? When they
3 declare that they're shutting down or when it gets fully
4 decommissioned? I don't know the answer to that.

5 MR. HISER: Don't quote me but I think it's
6 when they defuel and send a notification to the NRC
7 that they removed fuel from the core and they're not
8 -- and I think they can start to relax. Then once their
9 fuel --

10 MEMBER SUNSERI: Well, that would be
11 interesting then because maintain means retrievable
12 and in a form that you can use, right?

13 MR. HISER: Yes.

14 MEMBER SUNSERI: Okay, I got it, thank you.

15 MR. POEHLER: Okay. So this is just a list
16 of recent current harvesting activities. I'm not going
17 to read these, but a lot of them do have published
18 reports here that we provide links for, and you know,
19 a couple that I just want to highlight are the Zorita
20 reactor controls work, which is pretty recent. And
21 also the Ringhals and Oscarshem 2. The two bottom rows
22 were they're ongoing through SMILE, so we're going to
23 talk about that more on a subsequent slide.

24 So this slide kind of a bit summarizes the
25 previous slide, but some of our recent and current

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1 activities include neutron observer materials from
2 Zion, reactor internals from Zorita, and the various
3 metallic components through the OECDNEA Studsvik
4 Materials Integrity for Life Extension, or SMILE
5 project.

6 We are in addition pursuing additional
7 opportunities for more targeted harvesting from
8 domestic and international plants. That's focused on
9 high value components in alignment with the NRC
10 priorities, and we're working cooperation and
11 coordination with DOE and EPRI.

12 And finally the SMILE project. The basic
13 objective is harvesting characterization and testing
14 of metallic components from decommissioning Swedish
15 BWR and PWR plants.

16 Some of the components of interest are
17 reactor pressure vessel low alloy steels, stainless
18 steel internals such as the core shroud barrel, core
19 barrel welds or shrouded barrel welds, I should say,
20 baffle plates, baffle bolts, nickel alloy penetrations,
21 piping and steam generator tubes. The reactors that
22 are within the scope are the Ringhals 2 reactor, which
23 is a Westinghouse 3 loop PWR with around 30 effective
24 full power years.

25 Of interest is the Alloy 690 and Alloy 52

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1 weld metal from the world's second oldest replacement
2 steam generator, which was replaced in 1989. And the
3 oldest replacement RPV head, which was installed in
4 1995.

5 And the second reactor's Oscarshem 2 and
6 ABV Adam BWR, where they're on 30 effective full power
7 years. And the SMILE program is a highly leveraged
8 program for NRC. There are eight countries
9 participating, along with EPRI in the U.S., so it's
10 a good value.

11 And at this point, I'm going to turn it
12 over to Matt Hiser to present the remaining slides on
13 I think concrete and electrical. Matt?

14 MR. HISER: Okay, thanks. Thanks Jeff.
15 And hopefully my voice will hold out, if it doesn't,
16 I know Rob can carry us to the finish line. I also
17 just wanted to caveat that I am more of a metals guy,
18 like Rob and Jeff, we do have some of our colleagues
19 in concrete and electrical areas.

20 If you guys have more specific technical
21 questions on the drilling down, I'll have to phone a
22 friend, but I think I have enough working knowledge
23 to sort of present these.

24 This slide cover's concrete harvesting,
25 and like the prior couple slides ago, we've had to sort

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1 of capture recent current activities and then for where
2 we're going moving forward in each of these areas.

3 So the main recent activity in the concrete
4 harvesting was that some unirradiated concrete cores
5 from the SONGS, San Onofre Nuclear Generating Station,
6 were removed.

7 We've got a reference to the research
8 information letter that documents this. And there was
9 some investigations now, particularly looking at the
10 mineralogy and the irradiation level on this concrete
11 to assess how valuable it would be to look at irradiated
12 concrete from SONGS.

13 Based on what was found, I have a little
14 more on the next slide, but basically the conclusions
15 from that is that they do think they'll be looking at
16 irradiating concrete from SONGS would be of value.
17 So, that's sort of documented and discussed in that
18 research information letter that was published I think
19 maybe six months ago.

20 And then also, you know, just sort of to
21 build on that, staff is looking at, you know, actively
22 pursuing an opportunity to harvest irradiated concrete,
23 and that will help us understand radiation effects on
24 concrete performance. So this will be looking at
25 irradiated concrete from biological shield structure

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1 that is closest right outside the vessel wall reactor
2 vessel.

3 Looking to do some in-situ NDE testing,
4 as well as, you know, physically remove large sections
5 and do laboratory research looking at mechanical
6 testing, microstructural characterization,
7 benchmarking the damage progression against the plant
8 data to the point of, you know, sort of verifying and
9 validating models, and then even potentially looking
10 at further radiation.

11 So, maybe Jeff can help with this?

12 MEMBER HALNON: So, this is Greg. The
13 concrete, I mean, irradiation's important but we have
14 two plants out there that have concrete issues, but
15 it's not irradiation. Are you connected with that
16 program as well? Davis-Besse and Seabrook?

17 MR. HISER: Yes, and I know our concrete
18 folks are well aware of ASR issues as well. I believe
19 and I'll get out of my depth really quickly but it has
20 to do with a type of aggregate, I believe.

21 MEMBER HALNON: Right.

22 MR. HISER: And --

23 MEMBER HALNON: But the testing piece, it
24 just seems like, you know, concrete testing program,
25 you know, because you're doing intensive stress and,

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1 you know, compressive, that sort of thing. Is that
2 all one testing program? I mean, one testing group
3 so they have this conglomerate of knowledge about
4 concrete issues, or is it fragmented in some way?

5 MR. HISER: Yeah. No, and we've got our
6 SMEs. Yeah, we have a concrete group that this is what
7 they deal with and --

8 MEMBER HALNON: Okay.

9 MR. HISER: And we've had other projects
10 that have looked at concrete pathologies, including
11 the alkali-silica reaction or ASR, as well as other
12 pathologies. So --

13 MEMBER HALNON: It's the same materials
14 people?

15 MR. HISER: It's the same materials
16 people. So and --

17 MEMBER HALNON: Okay, that's what I was
18 curious about. And are we, you know, collating that
19 experience into one group?

20 MR. HISER: Yeah. So when the concrete
21 folks develop their priorities, they had knowledge of
22 all these other programs that they've done in the past,
23 as well as operating experience and needs, and they
24 went through the same exercise as the metals folks did,
25 came up with their priority lists.

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1 MEMBER HALNON: Okay.

2 MR. HISER: So yes. And we've got a couple
3 of them on if we need to phone a friend.

4 MEMBER HALNON: Okay.

5 MR. HISER: Okay.

6 CHAIR REMPE: Just out of curiosity, I
7 mean, there's different types of concrete, salt based
8 and things like that, and in your prioritization, I
9 assume both types are a concern, or maybe one type is
10 of more concern, or?

11 MR. HISER: Yeah, I think -- let's ask
12 Madhumita or Jose. Do you want to respond to that?
13 I know my short answer would be yes, but let Madhumita
14 answer it.

15 MS. SIRCAR: Okay. Yes, Madhumita
16 Sircar, I'm from the concrete side. Yes, one type is
17 more important than the other, like the BWR usually
18 at accumulative fluences and the second structure is
19 different. PWR, two loops, and three loops accumulate
20 higher fluence and sometimes the reactor is supported
21 directly on the biologic shield wall, which is very
22 close to the reactor pressure vessel, so that gets
23 higher accumulated fluence, and also performing of very
24 important support performance.

25 So, basically not all plants are equal,

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1 PWR plants are more important, two loops, three loops,
2 four loops, the accumulative fluence is lower than two
3 loops and three loops, but still it's higher than the
4 --

5 CHAIR REMPE: What I was curious about was
6 there's like the salt base -- when we talk about molten
7 core concrete reactions, there's different types, and
8 to my knowledge, BWR or PWR won't pick based on type
9 of concrete because they are that type of plant, it's
10 where they're located and what they can get nearby.
11 And does it seem to matter what type of concrete, is
12 what I'm asking?

13 MS. SIRCAR: Yes.

14 CHAIR REMPE: And that also --

15 (Simultaneous speaking.)

16 CHAIR REMPE: What you find is the most
17 susceptible?

18 MS. SIRCAR: Type of concrete was if it
19 is the more silica bearing -- then it was more
20 susceptible for radiation related degradation.

21 CHAIR REMPE: Thank you.

22 MR. TREGONING: Maybe I'll just add onto
23 that, so you're right. A lot of these pathologies are
24 aggregate sensitive, so not only in the U.S. but
25 internationally we've developed aggregate maps for

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1 where the plants are located and what type of quarries
2 were nearby so we have an understanding of the basis
3 of the aggregate. And that's something that our
4 concrete experts look at, not only for U.S. programs,
5 but international programs, to see what the
6 applicability is in a particular study, to what swath
7 the U.S. claims.

8 So understanding local site conditions is
9 of utmost importance to try to figure out again what
10 the applicability, and what the particular degradation
11 concerns are because again each of the aggregates have
12 different pathologies that they're susceptible to.

13 CHAIR REMPE: Thank you.

14 MR. HISER: And I'll try to keep us moving
15 forward. This slide sort of summarizes the key
16 findings from that research information letter from
17 the SONGS unirradiated concrete, and the focus of this
18 was to get someone in concrete to confirm that we have
19 the type of aggregate of they've seen significant
20 radiation effects, which as Madhumita just mentioned,
21 is silica bearing.

22 And so you can see in this figure here that
23 the silicon image, you know, is lit up pretty well so
24 he sort of confirmed what they found, what they thought
25 they were going to find based on the local mineralogy

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1 and the records they had.

2 But this gets us sort of the digging into
3 the records. You know, this was a relatively small
4 expense to look at unirradiated concrete, confirm now,
5 you know, hopefully later on in the decommissioning
6 process they'll be able to get some irradiated concrete
7 at the time. At the time based on decommissioning is
8 right to do that.

9 MEMBER BIER: Excuse me, a quick
10 follow-up question. On the aggregate, is that
11 something that would've been recorded at the time the
12 plant was built, or it's just guesswork after the fact
13 because the data was not gathered at the time?

14 MR. HISER: I'll offer -- yeah, let's Mita
15 respond to that in terms of what construction --

16 MS. SIRCAR: Yes, for this particular
17 plant, we worked with SONGS, the owner, and they have
18 some specification from the construction time, and also
19 they identified their source of the aggregates, so from
20 that and as Rob mentioned earlier with the geological
21 mapping around that area and the source, so we have
22 the combination of both.

23 MR. HISER: All right, moving on from
24 concrete to harvesting for fire research. And we've
25 got a couple of recent and current activities to

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1 mention, and these were noted in the slide a few slides
2 back, the table summarized all the activities.

3 So there were electrical enclosures that
4 were removed, and I believe there's a couple of NUREGs
5 that are cited back in that table.

6 We're looking at fire detection to keep
7 release rates and electrical enclosure fires, and then
8 more recently there's been electrical bus ducts
9 harvested from Zion a few years ago, and actually just
10 this year, really just in the last few months from
11 Crystal River 3 if you look at high energy arc fault
12 testing on most representative samples.

13 So got a couple more slides that sort of
14 touch a little bit more on the HEAF testing. And then
15 moving forward, fire research area they are looking
16 at opportunities to probably look at and try to acquire
17 aged electrical cables. And I think the focus is sort
18 of accessing fire resistances decreasing over time due
19 to aging. But that's something that has not started
20 or yet.

21 So this research I think is a good example
22 of how important it is to - and Ray talks about this
23 all the time -- it's important for the Office of Research
24 to be ready. So with this one, this is actually, you
25 know, we talk about how long and important and complex

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1 harvesting is.

2 With the fire research, we got a call from
3 a fire brethren, they had a small window, they could
4 add some test materials and for some testing that was
5 ongoing in August. I think they called us in maybe
6 May, April or May. And said, can you get us some
7 materials from harvesting? Can we get some harvested
8 materials to add to this test measure?

9 Matt and I looked at each other and said,
10 there's no way. But then we'd had enough contacts that
11 we started making calls both infernally and the agency
12 next to her.

13 I think within two weeks, we'd identified
14 materials and because they were not irradiated, they
15 were, get those materials, get them to the NRC test
16 facility, and they've actually been tested, so it's
17 probably the best example of the shortest, least
18 expensive, carefree harvesting activity we've ever
19 pursued at the NRC.

20 Again I think that's sort of testament to
21 the fact that we were planful and we were ready for
22 that opportunity when it came, and it allowed us to
23 act quickly on it, and that I believe is really the
24 essence of what we're trying to do with this harvesting
25 program.

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1 All right, the next couple slides just dig
2 a little more into the HEAF testing. If you have real
3 specific HEAF questions I'm going to very quickly pass
4 it along, but I'll just try to touch on this a little
5 bit, and you guys may have more familiarity because
6 I think you guys have a lot of attention on it recently,
7 but NRC's the operating agent of an OECD agreement.

8 That covers 21 tests jointly sponsored with NRC and
9 eight other countries. Just in this year ten medium
10 voltage tests were performed and eight of them were
11 performed on medium voltage non-segregated bus duct.

12 Recent research in a draft NUREG shows that
13 many of these have a zone of influence that may be
14 larger than what was originally proposed in previous
15 guidance, supplement 1, the NUREG-CR6850. And so these
16 tests provide valuable data to evaluate those models
17 and assess the HEAF hazard in medium voltage equipment.

18 Next slide.

19 This is one of the more fun slides with
20 little pictures before and after. So we're just going
21 to kind of focus on the tests on these harvested
22 materials which were from Crystal River. There were
23 two sections of three phase five kilovolt
24 non-segregated bus ducts that were acquired from
25 Crystal River. They were all aluminum bus ducts and

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1 bus bars.

2 Three conductors per phase. And these
3 ducts were used to complement six other ducts that were
4 procured new, and so they, you know, sort of answer
5 the question of what's representative of, you know,
6 what's in a real plant versus something that you buy
7 new today. And all eight of these were tested in the
8 same manner and measured for their response.

9 And the next bullet there touches on the
10 test parameters for four kilovolts, 30,000 amps, and
11 then two or four second pulse time. And then the --
12 and I'm not qualified really to speak of the technical
13 details of what's the results showed, but our colleagues
14 working on this in individual risk analysis and research
15 said that in their view, the preliminary results show
16 that the models are reasonably predicting the hazards.

17 They sort of confirmed what they expected to see based
18 on their models.

19 And you know, the pictures are really I
20 think, you know, enlightening. Hopefully we got a good
21 kind of before and after, you see what it looked like,
22 and then what it looks like after the fault.

23 MEMBER SUNSERI: Is there any appreciable
24 difference between the new ones that were tested and
25 the older ones?

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1 MR. HISER: Gabe, do you want to comment
2 on that?

3 MR. TAYLOR: Sure, can you hear me all
4 right?

5 MR. HISER: Barely.

6 MR. TAYLOR: All right. My name's Gabe
7 Taylor with the Office of Research and there were
8 definitely differences. It seemed that the new bus
9 ducts were better material, the fasteners were
10 smaller, the stuff that we harvested seemed to be just
11 more robustly built. You know, as far as, you know,
12 comparison from a thermal effect there really wasn't,
13 you know, too much difference that we saw with that
14 regard.

15 MEMBER SUNSERI: Thank you.

16 MR. HISER: Thanks Gabe. We just have one
17 more kind of technical area to talk to you on and then
18 I got about two or three sort of wrap-up slides, broader
19 wrap-up slides.

20 So this is touching on harvesting for cable
21 aging research. The main ongoing current activity is
22 looking at loss of a coolant accident test on electrical
23 cables and this includes some cables that were harvested
24 at the Zion plant, being aged within like 50, 60, and
25 80 years of operation. This was also noted in that

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1 earlier table.

2 I don't believe there's any final results.

3 I belie they're getting close, maybe within the next
4 year. And I don't want to promise for my colleagues,
5 but I think that was the comment they said, they're
6 getting pretty close to finishing up that program and
7 having, you know, a final report to share.

8 And then moving forward, we are looking
9 at opportunities to engage with external stakeholders
10 and identify harvesting opportunities representative
11 of cables in U.S. plants. We had a bit of dialogue
12 with EPRI on this. The likelihood that EPRI and DOE
13 and NRC will work together to harvest some more
14 materials. I'm particularly looking at validating NDE
15 techniques, and whether they can effectively track
16 cable degradation, and then also looking at aging
17 management and environment qualification on aged
18 cables.

19 MEMBER MARCH-LEUBA: Are you concerned
20 about neutron damage or radiation damage, or
21 atmospheric, oxidation on the sides of both?

22 MR. HISER: Yeah, I think it can be any,
23 radiation, wetting, temperature. There's a variety
24 of different mechanisms.

25 MEMBER MARCH-LEUBA: So you haven't --

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1 have the -- so that's where the previous comment that
2 you can get a 100 year old plan (phonetic) cables out
3 there, which you probably cannot buy at Home Depot
4 anymore because they're completely different
5 materials.

6 MR. HISER: Right. Yeah, and that gets
7 to one of the unique pieces that we didn't touch on
8 earlier, but that's one of the other values of
9 harvesting, is you know, getting the vintage
10 fabrication process, which they'd be better in some
11 ways working more robust, you know, maybe not as good
12 materials depending on the situation, you know. So
13 yeah, that's all part of the thinking here.

14 MEMBER SUNSERI: Sometimes on the cables,
15 the area of interest is where they've been spliced.
16 Maybe you get vices for those things?

17 MR. HISER: Mo, do you want to chime in,
18 or we'll phone a friend one last time hopefully.

19 MR. SADOLLAH: Sure. Can you hear me
20 okay?

21 MR. HISER: Yep.

22 MR. SADOLLAH: Okay. Yeah, this is Mo
23 Sadollah, research at Electrical and IC Branch. So
24 the material that we got, you know, they were from Zion
25 mostly, the ones that we could use. We got some from

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1 Crystal Rivers, but they were not long enough, and we
2 were able to take them. They were about 20 years old
3 but we were able to accelerate, age them to about 50,
4 60, and 80 years again and test them, run them through
5 a LOCA, and that was just completed.

6 And the question was -- I'm sorry, can you
7 repeat the question again just to make sure I don't
8 miss anything?

9 MEMBER SUNSERI: This is Matt Sunseri.
10 My experience a lot of times on these cable aging
11 management, the concern or the area of interest is where
12 the cable has been spliced.

13 MR. SADOLLAH: Yes, that's a great point
14 because you might've heard or you might know that most
15 electrical cable issues, damages occur at
16 determinations and splices. So far we have not been
17 able to gather any samples of the spliced cables. But
18 no, that's a good idea.

19 That's one thing that we also have on our
20 radar, to look more, and so far our cable research has
21 been focusing on the cables pretty much. Going
22 forward, we are kind of also including in that research
23 and that understanding the area of splices and
24 terminations on both ends of the cable. And we have
25 not been able to procure a spliced, aged, or naturally

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1 aged sample yet. Hopefully in the future we might be
2 able to put our hands on some.

3 MEMBER SUNSERI: Thank you.

4 MR. SADOLLAH: You're welcome.

5 MEMBER BIER: One other question. Kind
6 of touched on on that last slide indirectly, I assume
7 that a lot of these materials, or at least some of the
8 more important ones, would've been subjected to
9 accelerated life testing back when they were first
10 selected and installed. And has there been a
11 comparison to say how the accelerated life testing
12 compared to the real world experience? Is it mostly
13 pretty consistent or can it be wildy far off?

14 MR. SADOLLAH: That's also a good
15 question. This is one of the objectives of the research
16 we're doing, to see if you put a cable accelerate aging
17 in a laboratory environment basically, does it really
18 simulate, is it correlatable to aging that takes place
19 naturally in the field, in the containment, let's say?

20 That's one of the things we're looking at
21 right now as a part of this research, and going forward,
22 we'll probably look into that even a little bit more
23 in details. But yeah, now the cables that we normally
24 would find if they're AQ qualified cables, they would've
25 been type tested before.

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1 In other words, a section of similar cable
2 manufacturer and type and vintage, had been
3 accelerated, aged, and tested through LOCA, but the
4 cables that are installed themselves, no, they have
5 not been accelerated, aged as they were just, you know,
6 taken off the reel, installed, and they've been in that
7 environment like for Zion about 20 years in the
8 containment, and then we looked at it and tested it,
9 and then we kept even aging it further.

10 MR. TREGONING: I just wanted -- Rob
11 Tregoning -- I just wanted to expand. Great question,
12 Member Bier. That's something in all of our programs
13 we're concerned with comparing actual aging versus
14 accelerated aging because it doesn't matter if it's
15 metal, concrete, electrical, or cables, that's always
16 a fundamental consideration so that's one of the
17 principle things that we're trying to understand and
18 achieve with the harvesting program.

19 MR. BLEY: Rob?

20 MR. TREGONING: And I was -- go ahead, Mo.

21 MR. BLEY: This is Dennis. What'd you
22 say? Are there any cases where you've actually made
23 that comparison and can you tell us anything about the
24 result? Or is it just something you want to do?

25 MR. SADOLLAH: Like I said -- the only

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1 cables, samples that we were successful in getting and
2 testing were designed on cables. We had some cables
3 from Crystal River but they were not long enough, we
4 couldn't do much with them. Now these cables were only
5 I guess I should say 20 years old.

6 At 20 years of natural aging in plant
7 environments, they actually do not go through that much
8 of polymeric material changes. You do see some
9 exhaustion of the antioxidants and some changes of
10 filler material, but what we found is that the polymers
11 or the rubber material themselves, they don't age in
12 that short period of time.

13 So what we have seen so far, obviously there
14 is no samples out there that's 80 years to compare with
15 the 80 year old accelerated age samples that we have,
16 so not even, you know, we have some information about
17 50 year old samples accelerated age, but we don't have
18 good samples of cables that are aged even further.

19 The thought process is, and we're still
20 looking into it that, yeah, one main difference between
21 accelerated aging is typically all these cables, they
22 were qualified by exposing them to radiation and thermal
23 aging separately whereas in the plant they see radiation
24 and heat simultaneously. So whether or not there's
25 a synergistic effect, what we found preliminarily --

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1 and that report is going to come out next two or three
2 months -- the preliminary finding is that it really
3 depends.

4 Some material aged faster, better, or go
5 through more degradation by being aged simultaneously,
6 and some material don't show much difference whether
7 they're aged sequentially, radiation first and then
8 thermal.

9 So, the preliminary finding long story
10 short is that there's not that much difference between
11 how they're aged and how they are naturally aged in
12 service environments, but we're still looking into more
13 and it seems to be it's material dependent.

14 VICE CHAIR KIRCHNER: That's a real good
15 answer on cables. If I heard Rob correctly, he was
16 talking about other kinds of areas where the same kind
17 of -- you'd like to make the same kind of comparisons,
18 and Rob, are there any cases in mechanical equipment
19 and the like that have had that comparison done?

20 MR. HISER: Yeah, this is Matt Hiser.
21 I'll speak to the Zorita internals experience which
22 is a significant program we've done over the last ten
23 years or so, and I've recently put out a couple reports.

24 But I'd say it's similar to Mo, you know, that it's
25 a mix.

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1 In some areas, we've sort of confirmed what
2 other data was showing, but in some areas, you know,
3 our prior understanding to be non-conservative in a
4 couple areas.

5 So for instance with stainless steel plate
6 material, at low fluence levels we've pretty much
7 confirmed what we've seen before, low representing ten
8 to 20 DPA. At fairly high fluence levels above 20 DPA,
9 the materials we harvested tended to show a bit more
10 susceptibility to rapid crack growth rates, but really
11 no difference or not much difference in embrittlement.

12 So it depends a little bit on the properties and the
13 fluence levels you're talking about.

14 The other example is the stainless steel
15 welds that we tested, which is really focused on
16 embrittlement and fracture toughness.

17 It showed that they embrittled at a higher
18 rate and an earlier or lower dose, so industry had some
19 guidance that was being used, disposition flaws,
20 looking at -- and this has been discussed in public
21 meetings and has been looking at by EPRI and is being
22 addressed by industry, but some of that data showed
23 that basically these materials would embrittle to a
24 greater degree at a lower level of fluence than was
25 previously anticipated.

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1 So, you know, I think harvesting is
2 helping us but to Rob's point, in most of these areas
3 there's some data. It may be less representative, it
4 may be accelerated aging, you know, it may be a separate
5 thermal and radiation, you know, aging to replicate
6 it, and we're now getting what we think is a more
7 representative and a more true answer, and so we're
8 trying to have that guide us.

9 Some cases it says that the previous
10 research, you know, is spot on, in other cases it's
11 showing us new things.

12 VICE CHAIR KIRCHNER: Very interesting,
13 thanks.

14 MEMBER SUNSERI: So Matt, I hate to
15 interject here, we've got 15 minutes left on this
16 session, so. I believe you're doing a good job of
17 responding to their questions, but I just want to be
18 mindful of the time.

19 MR. HISER: Okay.

20 MEMBER BIER: One more quick follow-up.
21 It sounds like with that inconsistency of the answers,
22 it really means that kind of the basic science of what's
23 going on aging is not really well understood yet and
24 we may be getting some clues out of these comparisons.

25 Is that --

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1 MR. HISER: Correct, and I think you've
2 got to be careful in all of these, and in our analysis
3 of these results, for instance, we try to be careful
4 because, you know, in metals and I think in most
5 materials, there's heat to heat, or you know, a
6 fabricated variability, so if you've looked and you
7 think it's a more representation, but it's also just
8 one heated material, and maybe you're comparing it
9 against eight or ten other heats that have been studied
10 in a less representative way.

11 So you don't want to go overboard and say,
12 well this is, you know, the gospel truth, but you also
13 don't want to, you know, dismiss it because it is --
14 we are doing this because we think it's a more
15 representative aging. It is stuff right out of an
16 operating plant.

17 So, you know, we try to walk that line and
18 then if we find a discrepancy, then maybe that's a reason
19 to say let's maybe try to harvest one or two more, and
20 confirm or, you know, refute what the prior harvesting
21 showed.

22 MR. TREGONING: Rob Tregoning. Just
23 wanted to add quickly. So the thing that we're really
24 knowledgeable about, like a lot of scientists and
25 engineers, we try to understand and conduct separate

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1 effects testing. Right? Just like you do in thermal
2 hydraulics and other areas, right? You try to
3 understand the physics associated with the separate
4 effects.

5 It's the combined or integral or
6 synergistic -- I won't even use the term synergistic.

7 It's those combined effects that are more challenging
8 to replicate in the lab, and that's what we really get
9 out of the harvested materials.

10 So that's what ultimately makes them so
11 valuable. It allows us to assess those things that
12 are very challenging to accurately recreate in the lab.

13 And depending on the mechanism, we get an understanding
14 if these combined effects are important or not.

15 And that's incredibly valuable from my
16 perspective at the end of the day, regardless if you're
17 talking about metals, cables, or concrete.

18 MR. HISER: Okay, just about three slides
19 I think to wrap up.

20 So this slide is focused on harvesting
21 outreach, and I know Member Sunseri I think was at this
22 meeting -- maybe others as well -- but NRC held a public
23 meeting titled status of NRC harvesting activities in
24 late June, and we used this as an opportunity to update
25 the public on NRC harvesting activities and receive

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1 feedback from stakeholders.

2 This meeting featured presentations by the
3 NRC staff, partly myself, as well as representatives
4 from a couple different labs at DOE, Idaho National
5 Lab, Oak Ridge National Lab, staff from EPRI, the
6 Electric Power Research Institute, a couple
7 international organizations, Studsvik and actually
8 Vattenfall, which is the operator of the Ringhals plant,
9 that is participating and are providing a lot of the
10 materials for the SMILE program.

11 A very interesting perspective from an
12 international utility, and then finally Beyond Nuclear
13 gave a presentation. And we did just want to highlight,
14 you know, we're part of taking input, incorporate it
15 in whatever way we can.

16 One piece of feedback that we received from
17 this public meeting was to look at risk from internal,
18 external events and non-safety related components.

19 Oh, for example, flood penetration seals
20 on doors and other components that may have risk
21 significance to them relative to external flooding,
22 and that is something that we have discussed internally
23 but I think based on that feedback, we are
24 reinvigorating our efforts, and have actually started
25 having some discussions with the Department of Energy

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1 DOE lab staff at looking at opportunities to harvest
2 from some of the plants where we're already doing
3 harvesting, we already have that relationship with the
4 utility.

5 So we just wanted to kind of highlight that,
6 you know, this was an example of something that we were
7 able to take away from this public meeting. That was
8 feedback from external stakeholders that we're trying
9 to take to heart as we continue down the harvesting
10 path. Next slide.

11 And then just touching on harvesting
12 partnerships, as we mentioned earlier, leveraging
13 cooperation we think are very important. Harvesting
14 is expensive. To be honest I don't know if there's
15 a single example or maybe just one -- there's fairly
16 few examples, particularly on irradiated materials
17 components where NRC has done it by itself.

18 It's just very costly and complex, and so
19 we have, you know, in the past cooperated with DOE and
20 various DOE labs, the Electric Power Research
21 Institute, international organizations, the SMILE
22 program to accomplish, you know, in multiples sort of
23 NRC dollars.

24 We do have coordination, you know, we have
25 periodic calls and meetings with domestically and

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1 internationally to sort of share what's going on with
2 harvesting, what new opportunities may be coming up,
3 or it be a plant shutting down or different
4 organizations pursuing harvesting initiatives, they
5 may be looking for, you know, just to share information
6 or maybe looking for partners. We look for
7 opportunities where we can jump on things that we think
8 is a good use of, you know, of our limited resources.

9 Also I'll just mention here we have had
10 some workshops, helped co-lead a workshop in 2017, in
11 2020, and they're also expecting to have one coming
12 up later this year in conjunction with a SMILE meeting
13 so we try to keep connections with folks that are doing
14 this type of work outside the agency, and even outside
15 the country.

16 And then just a final wrap-up slide. Just
17 conclusions and key messages. Harvesting we think is
18 an important tool to help improve our understanding
19 of materials and component aging that can help inform,
20 you know, license renewal, subsequent license renewal,
21 aging management approaches, and our previous knowledge
22 of how materials age.

23 We are pursuing a proactive harvesting
24 strategy that includes maintaining and updating our
25 harvesting priorities, seeking harvesting

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1 opportunities from domestic and international sources
2 that align with our opportunities, you know, and then
3 ultimately and pursuing specific harvesting
4 initiatives and subsequent research that results from
5 that.

6 We do try to maximize our collaboration
7 with other organizations, such as EPRI, DOE, and
8 international counterparts where it makes sense, and
9 then that helps us to get the maximum benefit for the
10 lowest cost to the U.S. taxpayer to achieve NRC
11 objectives.

12 I appreciate the opportunity to brief the
13 committee and certainly happy to field any questions.

14 MEMBER SUNSERI: Great, thank you.
15 Members, any other questions for the presenters?

16 VICE CHAIR KIRCHNER: This is probably not
17 a quick one. You said you had a model for just about
18 everything. Where's the feedback loop in all of this?

19 In RES you get data. Have you been able to measurably
20 improve your models, particularly with regard to age
21 and/or fluence?

22 MR. HISER: I think Rob made a comment
23 about having a model for everything so I'll let him
24 answer this.

25 VICE CHAIR KIRCHNER: Yeah, probably for

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1 Rob.

2 MR. TREGONING: There's an answer for
3 everything too. Rob Tregoning, NRC staff. Again,
4 it's really dependent and it's really fluid, but yeah,
5 I mean, this is the ultimate validation, right? So
6 if you can't demonstrate your models using actual
7 materials then it causes you to reconsider those models.

8 VICE CHAIR KIRCHNER: Any highlights
9 though? You know, in particular that so far because
10 you've been doing this, you've been able to --

11 MR. TREGONING: Actually improve the
12 models? The one thing I haven't talked about that we
13 didn't talk a lot about was the baffle former bolt issue.
14 That's a little bit more mature.

15 There was some initial screening models
16 that were developed by industry and they didn't account
17 for all the different failure modes that they could
18 actually, those bolts would experience, so once they
19 started seeing some operating experience and then they
20 did -- they pulled bolts, they did root cause analyses.

21 They were able with that additional information to
22 go back and update their models, try to account for
23 these new failure mechanisms.

24 That's probably a good recent example where
25 information, not only operating experience, but

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1 operating experience coupled with harvesting has been
2 used explicitly to refine and improve models. Matt
3 talked about our Zorita experience and we've got some
4 very interesting results.

5 We're at the point where we're trying to
6 understand how we do need to modify our models to
7 incorporate and account for these results, so sometimes
8 it's easy to do, sometimes it requires a little bit
9 more exploration. And at least for the Zorita models
10 we're in that a little more exploration stage to try
11 to understand how we need to tweak our models.

12 MR. HISER: And it depends on the models.

13 You know, the model is relevant to the Zorita
14 experience, but more empiricals, so now it's how are
15 we layering, how are we analyzing prior experimental
16 data to this new experimental data and, you know, and
17 weighing each of those?

18 You know, the baffle-former bolts, they
19 were clear just new phenomenon that really hadn't been
20 considered in the original models, so it's maybe not
21 easier but, you know, a greater, a different way of
22 updating the model.

23 MEMBER SUNSERI: Anything else?

24 (No audible response.)

25 MEMBER SUNSERI: All right, I guess I'll

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1 open it up for any public comments. Anybody listening
2 in, if you have a statement you want to make go ahead
3 and make your statement. State your name and make
4 your statement.

5 (No audible response.)

6 MEMBER SUNSERI: All right, we have
7 another five seconds.

8 CHAIR REMPE: Only that five seconds? I
9 want to thank the staff and RES for being willing to
10 come and brief us. I think this helps us not only for
11 our eventual research report that we issued but also
12 just gives us more knowledge of what's going on. So
13 I appreciate it, and I appreciate Matt and Hossein
14 helping facilitate this, and I guess that's all I have
15 to say.

16 We are now going to go off the record for
17 the court reporter for this whole meeting, and we'll
18 come back at ten after to resume our letter on the fusion
19 SECY which has become very popular. Okay. Thank you
20 everybody.

21 (Whereupon, the above-entitled matter went
22 off the record at 2:55 p.m.)

23

24

25

Update on NRC Materials Harvesting Activities

Matthew Hiser, Jeffrey Poehler, and Robert Tregoning
NRC Office of Nuclear Regulatory Research

October 6, 2022

ACRS Briefing

Outline

- Background
- Motivation and Strategy
 - Harvesting Priorities
 - Previously Harvested Materials
 - Harvesting Opportunities
- Recent and Current Activities
 - Metals, Concrete, Fire Research, Electrical
- Outreach and Partnerships
- Conclusions and Key Messages

Materials Harvesting Background

- Historically, NRC, industry and others have performed research on materials harvested from a broad range of components
- Current harvesting objectives focus on materials aging during long-term operation:
 - Confirm results from laboratory experiments and analytical simulations to improve understanding of aging by testing materials aged in operating plants
 - Reduce uncertainty in current state of knowledge of aging and NDE effectiveness to enable informed NRC review of aging management programs



Figure: Control rod drive mechanism (CRDM) Nozzle 63 from the North Anna Unit 2 reactor ([NUREG/CR-7142](#))

Current Situation

- In the past, harvesting efforts have generally been reactive as limited new opportunities arose
 - Few plants shutting down led to more “demand” than “supply”
- In recent years, a significant number of plants have shut down and entered the decommissioning process
 - Generally operated for a long period, which provides more highly aged components for harvesting
 - Currently more “supply” of harvesting opportunities than in the past
- Current situation calls for a more proactive strategic approach

A Strategic Approach to Harvesting

- In 2015, NRC began an effort to develop a materials harvesting strategy
 - NRC previously was very reactive to harvesting opportunities
- Harvesting challenges
 - Expensive, complex, and time-consuming (particularly with irradiated materials)
 - Documentation of component fabrication and aging conditions
 - Decommissioning vs. harvesting



- **Strategy:** Focus on high-value harvesting opportunities
 - Seek cooperation when possible to maximize limited NRC resources

Proactive Harvesting Strategy

1. Identify and prioritize harvesting interests

- Focused on the unique value of harvesting relative to other sources of information (e.g. accelerated aging, operating experience)

2. Consider use of previously harvested materials when possible

- Greatly reduced cost, time and complexity compared to new harvesting
- Limited in the range of materials and aging conditions represented

3. Gather information on harvesting opportunities

- Requires sufficient information to meaningfully compare to priorities
- Challenging to acquire across the population of decommissioning plants

Technical Prioritization Criteria

Criticalness of Technical Issue Addressed

- Higher safety significance and less available data leads to higher ranking

Importance of Harvested Materials over Laboratory Aging

- In-plant aging conditions or materials that are more difficult to replicate in the lab leads to higher ranking

Applicability to US Operating Fleet

- Applicability to a greater number of plants leads to higher ranking

Regulatory Considerations Related to Inspections and AMPs

- Greater availability and confidence in inspection methods or aging management approaches leads to lower ranking

High Priorities - Metals

Interest Description	Purpose / Testing Planned	Technical Knowledge Gained	Harvesting Status
600 thermally treated (TT) steam generator (SG) tubes with shallow flaws	Non-destructive examination (NDE) and mechanical testing	NDE assessment / detection and structural integrity for shallow flaws	Seeking opportunities
Thermally aged unirradiated cast stainless steel (CASS)	Fracture toughness and microstructure	Fracture toughness data in real conditions to compare to accelerated aging data	Identified and pursuing opportunity
Bottom-mounted instrumentation (BMI) nozzles with known PWSCC indications	Residual stress measurements and crack initiation/growth testing	Confirm adequacy of current inspection requirements	Seeking opportunities – very few plants with known BMI indications
	Flaw characterization	Confirm NDE effectiveness and flaw distribution	
Higher fluence stainless steel (SS) welds (>2 dpa)	Fracture toughness, IASCC CGR, and microstructure	Properties to inform inspection scope and interval and flaw evaluation	Addressed by SMILE* and other opportunities

*SMILE = Studsvik Materials Integrity for Life Extension

High Priorities - Concrete/Structural and Electrical

Interest Description	Purpose / Testing Planned	Technical Knowledge Gained	Harvesting Status
Irradiated concrete	<ul style="list-style-type: none"> • In-situ and in-service data for model verification • In-situ NDE • Mechanical and microstructural properties characterization • Benchmark structural damage • Potential further irradiation 	<ul style="list-style-type: none"> • Confirmatory testing and uncertainties reduction • Evaluating rate effects (in-service conditions vs accelerated irradiation) • size effects (real structure vs test specimen in test reactor) • Evaluating concrete radiation and damage depth/gradients in concrete bioshield • Inform structural integrity evaluation and inspection 	Identified and actively pursuing opportunity.
Reactor supports	Embrittlement, fracture toughness, microstructure	Structural integrity and performance. Inform inspection scope.	Identified and pursuing opportunity.
Electrical Cables (low and medium voltage)	Comparison of service aged specimen with accelerated-aged samples. Assess NDE effectiveness. Assess fire spread and thermal failure criteria.	Confirm technical basis for aging management programs.	Seeking opportunities.

Previously Harvested Materials

- NRC staff have catalogued previously harvested materials from prior NRC-sponsored research, including:
 - PNNL – large array of components from penetrations up to large piping sections used for NDE research
 - Battelle – large primary system piping and elbows
 - ANL – smaller irradiated reactor internals materials
- Other sources of previously harvested materials:
 - U.S. Department of Energy (DOE) Nuclear Fuels and Materials Library (NFML)
 - Studsvik – SMILE-related and other harvested materials
 - Halden Reactor Project



Harvesting Opportunities

- NRC has worked with EPRI to develop a harvesting opportunities table
 - Covers domestic and international harvesting opportunities (decommissioning or announced shutdown date plants)
- Examples of column headings shown below:

Plant	Utility	Design	Size (MWe)	Core Inlet / Outlet Temp (°C)	Years in operation	Shutdown Date	Harvesting or Decommissioning Plan / Timeline	Research Organizations	Summary of Components Previously Discussed						
									RPV Beltline			PWR RPV Head Penetrations / BWR Instrumentation Penetrations			Baffle Plate
	Material (Alloy & Fabrication Method)	Environment (dpa, temp, water chemistry)	OpE or other info	Material (Alloy & Fabrication Method)	Environment (EFPY, temp, water chemistry)	OpE or other info	Material (Alloy & Fabrication Method)	Environment (dpa, temp, water chemistry)	OpE or other info	Material (Alloy & Fabrication Method)	Environment (dpa, temp, water chemistry)	OpE or other info	Material (Alloy & Fabrication Method)	Environment (dpa, temp, water chemistry)	OpE or other info

Recent and Current Harvesting Activities

Plant	Components Harvested	Status
Bellefonte	Electrical enclosures	NUREG-2180 ; NUREG/CR-7197
Zion	Neutron absorber materials	ML19155A215
	Electrical cables	Testing ongoing
	Electrical bus ducts	OECD/NEA/CSNI/R(2017)7
Crystal River 3	Electrical bus ducts	Testing recently completed
Zorita	Reactor internals	ML22132A039 ; ML20198M503
SONGS 2	Unirradiated concrete	ML22119A092
Ringhals 2	RPV, internals, RPV penetrations, SG tubes, piping	OECD/NEA SMILE ongoing through 2025
Oskarshamn	RPV, internals, piping	

Metals Harvesting

- Recent and current activities:
 - Neutron absorber materials from Zion
 - Reactor internals from Zorita
 - Various metallic components through OECD/NEA Studsvik Materials Integrity for Life Extension (SMILE) Project
- Pursuing additional opportunities for more targeted harvesting from domestic and international plants
 - Focused on high-value components in alignment with NRC priorities
 - Working in cooperation and coordination with DOE and EPRI

SMILE Project Overview

- Harvesting, characterization and testing of metallic components from decommissioning Swedish BWR and PWR
 - Reactor pressure vessel low alloy steel
 - Stainless steel internals: core shroud / barrel welds, baffle plate, baffle bolts
 - Nickel alloy penetrations, piping, and steam generator tubes
- Reactors:
 - Ringhals 2: Westinghouse 3-loop PWR with ~ 30 EFPY
 - Alloy 690 and Alloy 52 weld metal from the world's second oldest replacement steam generator (1989) and oldest RPV head (1995)
 - Oskarshamn 2: ABB-Atom BWR with ~30 EFPY
- Highly leveraged program for NRC with 8 countries participating along with EPRI

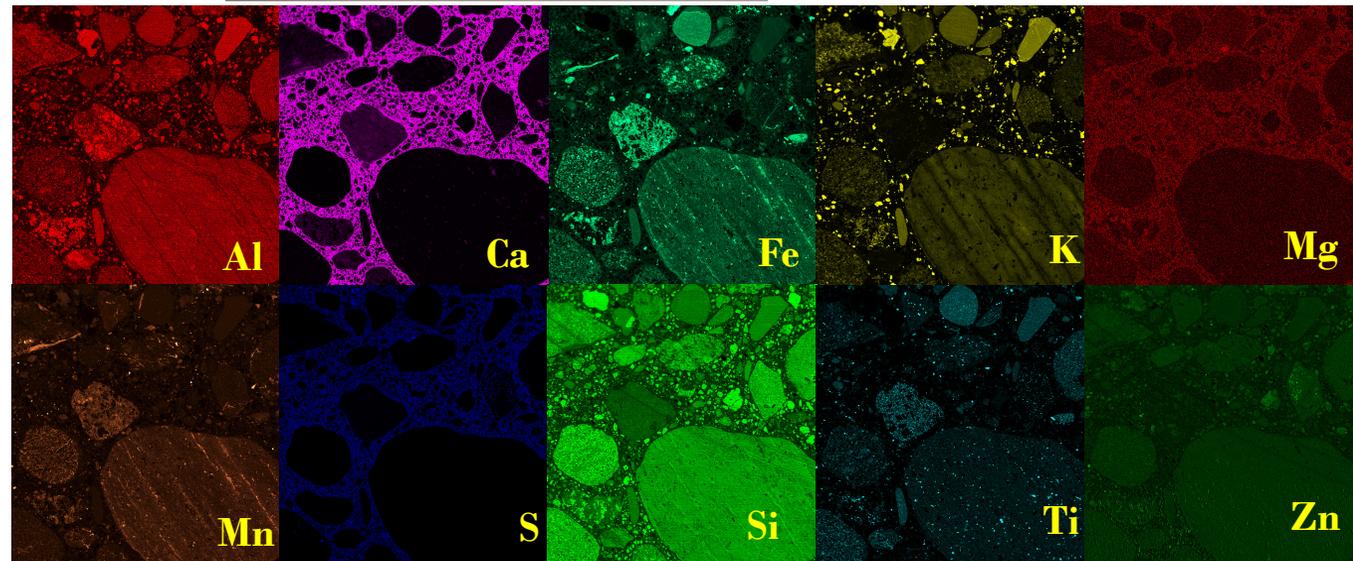
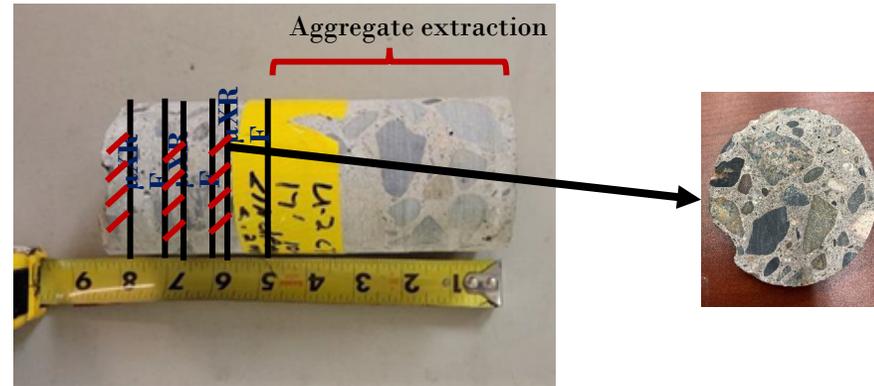
Concrete Harvesting

- Recent and current activities:
 - Harvested unirradiated concrete from San Onofre Nuclear Generating Station (SONGS) 2 to evaluate its susceptibility to irradiation ([RIL 2022-07](#))
 - Based on mineralogy and irradiation level, irradiated concrete from SONGS would be a valuable opportunity to study irradiation-assisted concrete degradation
 - Obtained from SCE available plant documents, reports, drawings and concrete specifications
 - Drafted potential research plan
- Actively pursuing opportunity to harvest irradiated concrete to improve understanding of irradiation effects on concrete performance with harvest and research scope to include:
 - Harvest irradiated concrete from biological shield structures
 - In-situ testing and NDE
 - Laboratory research (mechanical testing, microstructural characterization), benchmarking damage progression in bioshield against SONGS data, and potential further irradiation

SONGS Unirradiated Concrete Evaluation

- 3 unirradiated cores harvested from the steam generator enclosure.
- Large content of silicates in fine-grained aggregates
- Various characterization methods: UPV, μ XRF, petrography, XRD, SEM

3 slices were cut for petrography and μ XRF



Harvesting for Fire Research

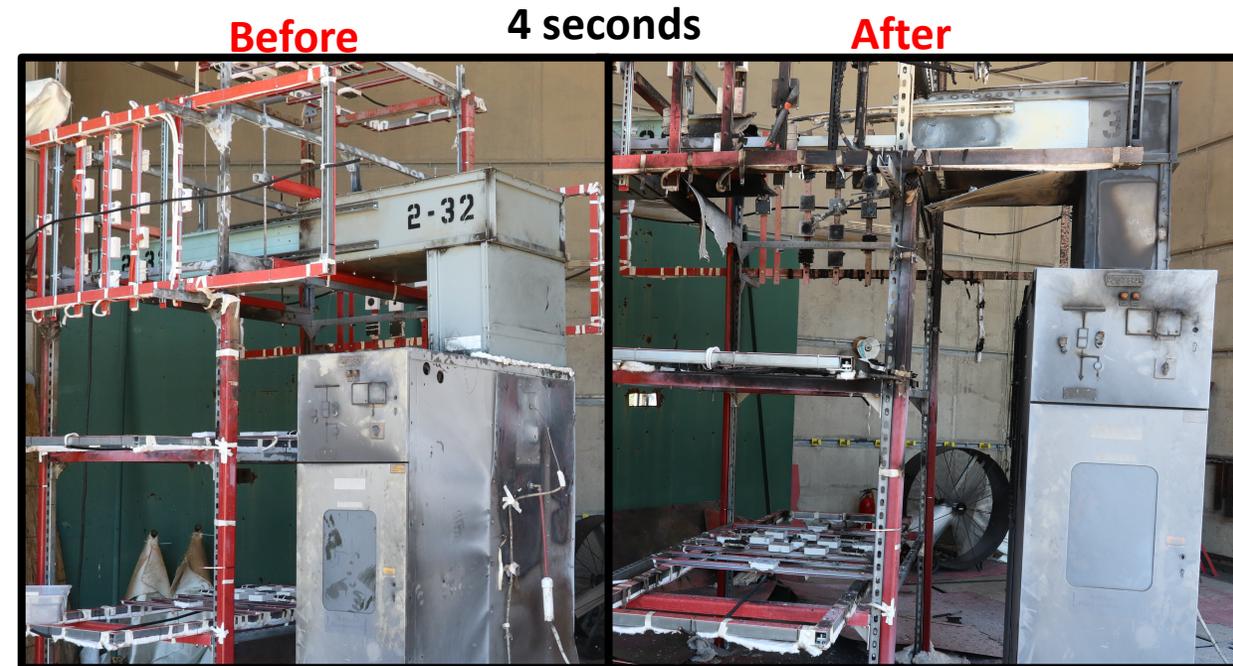
- Recent and current activities:
 - Electrical enclosures from Bellefonte to study fire detection and heat release rates in electrical enclosure fires
 - Electrical bus ducts from Zion and Crystal River 3 to perform high-energy arc fault (HEAF) testing on representative samples
- Seeking opportunities to acquire and study aged electrical cables to determine if fire resistance is decreased after aging

High Energy Arcing Fault Experimental Series

- NRC is the operating agent under an OECD/NEA HEAF 2 Agreement.
 - Agreement covers 21 tests sponsored jointly between the NRC and eight other member countries
- In 2022, 10 medium voltage tests were performed. Eight of those tests were medium-voltage non-segregated bus duct.
- Recent research (draft NUREG-2262) indicates that many bus duct scenarios have a damage region (zone of influence) larger than originally proposed in guidance (Supplement 1 to NUREG/CR-6850).
- These tests provide valuable data to evaluate the latest models to assess the HEAF hazard in medium-voltage equipment.

Equipment Harvested for HEAF Testing

- Harvested materials: Two sections of 3-phase 5kV, 2,000 A, non-segregated bus ducts were acquired from Crystal River 3.
 - All aluminum bus duct and bus bars; 3 conductors per phase.
- These ducts complement the six other ducts that were procured new.
 - All 8 ducts were tested in a common manner and measured for thermal response.
- Test parameters were 4.16kV, 30kA, 2 or 4 seconds
- Preliminary results show models are reasonably predicting the hazard.



Harvesting for Cable Aging Research

- Recent and current activities:
 - Currently performing loss-of-coolant accident (LOCA) tests on electrical cables (including some harvested cables from Zion) aged to simulate 50, 60, and 80 years of operation
- Seeking opportunities to engage with external stakeholders to identify harvesting opportunities that are representative of cables installed in U.S. plants
 - Harvested materials will be helpful to validate whether NDE techniques can effectively track the degradation of electrical cables and cable accessories over their service life
 - Future plans focus on addressing topics related to cable condition monitoring, aging management, and environmental qualification

Harvesting Outreach

- NRC held a [public meeting](#)* on “Status of NRC Harvesting Activities” in June 2022 to update the public on NRC harvesting activities and receive feedback from stakeholders.
 - The meeting featured presentations by the NRC staff, DOE, EPRI, international organizations (Studsvik and Vattenfall) involved with harvesting, and Beyond Nuclear.
- One topic raised by public was to consider risk from external events and non-safety related components such as flood seals in developing harvesting priorities.
 - As a result of this feedback, the staff is exploring opportunities to harvest flood seals from decommissioning plants

*Meeting summary and presentations are at [ML22178A155](#).

Harvesting Partnerships

- Partnering and information sharing is essential to manage the costs and complexity associated with harvesting activities
- Past NRC cooperation on harvesting has involved:
 - U.S. Department of Energy (DOE)
 - Electric Power Research Institute (EPRI)
 - International organizations
- Coordination achieved via periodic calls and meetings with domestic and international researchers

Conclusions and Key Messages

- Harvesting is an important tool for enhancing our understanding of materials and component aging
- NRC is pursuing a proactive harvesting strategy that includes:
 - maintaining and updating harvesting priorities
 - seeking harvesting opportunities from domestic and international sources that align with priorities
- NRC maximizes collaboration with other organizations such as EPRI and DOE to gain the maximum benefit for the lowest possible cost

Acronym List

- ANL Argonne National Laboratory
- B&W Babcock and Wilcox
- BWR Boiling water reactor
- CE Combustion Engineering
- CGR Crack growth rate
- DOE Department of Energy
- EPRI Electric Power Research Institute
- FT Fracture toughness
- IASCC Irradiation-assisted stress corrosion cracking
- INL Idaho National Laboratory
- μ XRF Micro X-ray fluorescence
- MWt Megawatt-thermal
- NDE Nondestructive examination
- NEA Nuclear Energy Agency
- OECD Organization for Economic Co-operation and Development
- PNNL Pacific Northwest National Laboratory
- PWR Pressurized water reactor
- PWSCC Primary water stress corrosion cracking
- RPV Reactor Pressure Vessel
- SCC Stress corrosion cracking
- SEM Scanning electron microscopy
- SMILE Studsvik Materials Integrity for Life Extension
- SONGS San Onofre Nuclear Generating Station
- SS Stainless steel
- TEM Transmission electron microscopy
- UPV Ultrasonic pulse velocity
- XRD X-ray diffraction

A sampling of harvesting related reports...

1. J.R. Hawthorne and A.L. Hiser, *Experimental Assessments of Gundremmingen RPV Archive Material for Fluence Rate Effects Studies*, [NUREG/CR-5201](#) (MEA-2286), U.S. Nuclear Regulatory Commission, October 1988.
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3. O.K. Chopra, and W.J. Shack, *Mechanical Properties of Thermally Aged Cast Stainless Steels from Shippingport Reactor Components*, [NUREG/CR-6275](#) (ANL-94/37), U.S. Nuclear Regulatory Commission, April 1995.
4. G. J. Schuster, S. R. Doctor, S.L. Crawford, and A. F. Pardini, *Characterization of Flaws in U.S. Reactor Pressure Vessels: Density and Distribution of Flaw Indications in the Shoreham Vessel*, [NUREG/CR-6471 Volume 3](#), U.S. Nuclear Regulatory Commission, November 1999.
5. G. J. Schuster, S. R. Doctor, A.F. Pardini, and S.L. Crawford, *Characterization of Flaws in U.S. Reactor Pressure Vessels: Validation of Flaw Density and Distribution in the Weld Metal of the PVRUF Vessel*, [NUREG/CR-6471 Volume 2](#), U.S. Nuclear Regulatory Commission, August 2000.
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