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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

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UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

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699TH MEETING

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

(ACRS)

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THURSDAY

OCTOBER 6, 2022

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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

DESIGNATED FEDERAL OFFICIAL:

MICHAEL SNODDERLY

DEREK WIDMAYER

ALSO PRESENT:

ELIJAH DICKSON, NRR

JEREMIAH DOYLE, NuScale

TYLER ELLIS, Public Participant

SID FOWLER, Public Participant

RAYMOND FURSTENAU, RES

MATTHEW HISER, RES

STEVE LYNCH, NRR

SCOTT MOORE, ACRS

JEFFREY POEHLER, RES

ANDREW PROFFITT, NRR

WILLIAM RECKLEY, NRR

MO SADOLLAH, RES

DIEGO SAENZ, Department of Homeland Security

MOHAMED SHAMS, NRR

MADHUMITA SIRCAR, RES

JOSEPH STAUDENMEIER, RES

GABE TAYLOR, RES

ROBERT TREGONING, RES

DUNCAN WHITE, NMSS

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

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

through our Procedures and Planning meeting discussion.

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

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

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

MEMBER SUNSERI: Thank you, Chair Rempe. So my name's Matt Sunseri, I'm the ACRS lead member for the engineering section of our periodic review of the NRC Safety Research Program. We've asked staff to be here today with us to have a informational briefing updating us on activity since our last periodic review.

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

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

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

Regulatory Research Office. Ray?

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

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

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

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

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

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

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

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

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

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

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

It also can support as we look into aging beyond 80 years, you know, 60 to 80, but beyond 80 you may have plans that might want to do that later on. So I think that this all ties into that quite well, so I'm kind of excited the group of folks that you have. I'm going to get off of here, let the smart people talk.

So I'm going to turn it over to Jeff Poehler and Matt Hiser, and give up my chair to Rob Tregoning, and I think they can answer any questions that come. So again, thanks for the opportunity.

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

(No audible response.)

MEMBER SUNSERI: All right. Well, thanks

for those opening remarks. Jeff?

MR. POEHLER: Can everyone hear me?

(Off-microphone comment.)

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

MR. POEHLER: How's that?

(Simultaneous speaking.)

MR. POEHLER: How's that?

(Off-microphone comment.)

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

Matt is going to be presenting the second half of the slides, and I kind of have to introduce myself because I'm kind of new to the harvesting area. I'm taking over Matt's role. Matt has really been the lead and the subject matter expert in research on harvesting for several years at least.

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

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

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

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

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

So, oops, I skipped a slide.

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

focus on materials aging during long-term operation.

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

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

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

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

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

situation calls for a more proactive, strategic approach.

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

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

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

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

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

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

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

(Simultaneous speaking.)

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

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

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

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

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

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

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

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

MR. HISER: Can I just add --

MR. POEHLER: Go ahead.

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

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

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

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

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

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

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

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

Hopefully that kind of helps give a little bit more.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

So you know, because of all these challenges, the NRC staff is just, you know, basically trying to focus on high value harvesting opportunities. And also to seek cooperation and collaboration when possible to maximize limited NRC resources.

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

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

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

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

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

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

(Simultaneous speaking.)

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

(Simultaneous speaking.)

(Laughter.)

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

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

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

And fourth, regulatory considerations related to inspections in aging management programs. So greater availability and confidence in inspection methods or aging management approaches leads to a lower ranking, so if you have a component that has a robust inspection program or condition monitoring program that gathers a lot of data regularly, versus a component where you really have difficulty inspecting it, like certain parts of the reactor internals and things like

that are difficult to inspect.

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

MR. POEHLER: So --

MR. HISER: Can I --

MR. POEHLER: Yeah, go ahead, Matt.

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

(Audio interference.)

MR. HISER: Oh, sorry.

(Audio interference.)

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

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

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

difficult, you know, or not at all possible to inspect. Those may be the types of issues that on safety significant components, we would focus more on for harvesting. And I apologize for my voice.

CHAIR REMPE: I have a --

(Simultaneous speaking.)

CHAIR REMPE: Well, okay. I apologize if you've already said this, but this is something that just the NRC staff uses for your prioritization, or do you ever include other experts that are in the fields? I'm glad to hear you consider what else is going on in the field, but this is just an internal research organization that is doing the ranking?

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

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

MR. HISER: Oh --

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

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

rankings.

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

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

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

We haven't really done an update in about

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

CHAIR REMPE: That helps, thank you.

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

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

(No audible response.)

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

MR. HISER: Yeah, I understand.

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

(Audio interference.)

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

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

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

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

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

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

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

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

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

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

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

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

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

VICE CHAIR KIRCHNER: Well maybe we'll get

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

MR. POEHLER: You'll see that. That's --

(Simultaneous speaking.)

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

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

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

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

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

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

MEMBER MARCH-LEUBA: Not a quantity of 600.

MR. POEHLER: Alloy 600 is the end.

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

MR. POEHLER: No.

MR. HISER: No, alloy.

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

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

The status is we're seeking opportunities

to harvest these type of tubes.

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

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

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

The knowledge we'd like to gain is to confirm the adequacy of current inspection requirements and confirm the NDE effectiveness of flaw distribution. We're currently seeking opportunities. There are few plants with known BMI indications.

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

(Simultaneous speaking.)

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

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

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

CHAIR REMPE: Does it matter?

(Simultaneous speaking.)

CHAIR REMPE: I mean, the different

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

MR. POEHLER: I --

CHAIR REMPE: Or CE ones?

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

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

CHAIR REMPE: Yeah.

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

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

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

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

CHAIR REMPE: Thank you.

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

The first one there is irradiated concrete. You can see there's a lot of different testing that we would like to do on that, and that includes in-situ and in-service data for model verification, in-situ NDE mechanical and microstructural properties characterization, bench marking of structural damage, and the potential, you know, for further irradiating these materials.

The knowledge we'd like to gain there is to, you know, reduce the uncertainties in models, evaluating rate effects of in-service conditions versus accelerating radiation, size effects. That is real structures versus test specimens and a test reactor. Evaluating concrete radiation and damage, depth, gradiance and concrete bioshield, and to inform structural integrity evaluation and inspection.

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

The next one here is reactor supports.

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

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

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

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

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

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

(Simultaneous speaking.)

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

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

MR. FURSTENAU: Yeah, it's Ray Furstenau. And I was going to say because I mean, there's a lot of old fossil plants that aren't being used right now, 50, 60, 70, sometimes 80, 90 years old, so.

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

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

program.

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

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

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

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

And also the Halden Reactor Project.

This is basically showing a little snippet of the column headings from the joint harvesting opportunities table that NRC has worked with EPRI to develop. It covers both domestic and international harvesting opportunities for both plants that are decommissioning now or have announced shutdown dates. And this is just providing examples of the headings for the columns and what types of information.

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

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

MR. TREGONING: Okay. Can I ask --

MR. POEHLER: Go ahead.

MR. TREGONING: Yeah, we had a question

earlier about documentation.

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

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

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

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

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

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

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

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

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

CHAIR REMPE: How willing are the decommissioning companies to provide the information? Because you said that's one of the first things they destroy. Are they willing to share?

MR. TREGONING: It depends on the decommissioning company. And I think Matt talked earlier, this is not their prime business objective. And so finding a willing partner that is engaged in harvesting, that's a very difficult challenge.

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

CHAIR REMPE: Right.

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

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

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

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

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

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

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

MR. FURSTENAU: Yeah, it was not maintained.

CHAIR REMPE: But you got to catch it, and

it's --

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

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

MR. TREGONING: It's totally a potpourri.

MR. FURSTENAU: Yeah, it just varies.

(Simultaneous speaking.)

MR. TREGONING: The plant --

(Simultaneous speaking.)

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

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

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

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

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

MR. HISER: Yes.

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

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

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

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

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

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

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

Of interest is the Alloy 690 and Alloy 52

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

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

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

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

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

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

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

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

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

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

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

that is closest right outside the vessel wall reactor vessel.

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

So, maybe Jeff can help with this?

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

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

MEMBER HALNON: Right.

MR. HISER: And --

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

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

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

MEMBER HALNON: Okay.

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

MEMBER HALNON: It's the same materials people?

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

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

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

MEMBER HALNON: Okay.

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

MEMBER HALNON: Okay.

MR. HISER: Okay.

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

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

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

So, basically not all plants are equal,

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

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

MS. SIRCAR: Yes.

CHAIR REMPE: And that also --

(Simultaneous speaking.)

CHAIR REMPE: What you find is the most susceptible?

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

CHAIR REMPE: Thank you.

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

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

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

CHAIR REMPE: Thank you.

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

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

and the records they had.

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

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

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

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

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

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

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

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

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

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

harvesting is.

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

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

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

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

All right, the next couple slides just dig a little more into the HEAF testing. If you have real specific HEAF questions I'm going to very quickly pass it along, but I'll just try to touch on this a little bit, and you guys may have more familiarity because I think you guys have a lot of attention on it recently, but NRC's the operating agent of an OECDA agreement. That covers 21 tests jointly sponsored with NRC and eight other countries. Just in this year ten medium voltage tests were performed and eight of them were performed on medium voltage non-segregated bus duct.

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

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

bus bars.

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

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

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

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

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

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

MR. HISER: Barely.

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

MEMBER SUNSERI: Thank you.

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

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

earlier table.

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

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

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

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

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

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

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

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

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

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

MR. HISER: Yep.

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

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

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

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

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

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

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

MEMBER SUNSERI: Thank you.

MR. SADOLLAH: You're welcome.

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

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

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

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

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

MR. BLEY: Rob?

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

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

MR. SADOLLAH: Like I said -- the only

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

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

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

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

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

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

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

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

MR. HISER: Yeah, this is Matt Hiser. I'll speak to the Zorita internals experience which is a significant program we've done over the last ten years or so, and I've recently put out a couple reports. But I'd say it's similar to Mo, you know, that it's a mix.

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

So for instance with stainless steel plate material, at low fluence levels we've pretty much confirmed what we've seen before, low representing ten to 20 DPA. At fairly high fluence levels above 20 DPA, the materials we harvested tended to show a bit more susceptibility to rapid crack growth rates, but really no difference or not much difference in embrittlement. So it depends a little bit on the properties and the fluence levels you're talking about.

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

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

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

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

VICE CHAIR KIRCHNER: Very interesting, thanks.

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

MR. HISER: Okay.

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

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

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

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

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

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

It's the combined or integral or synergistic -- I won't even use the term synergistic. It's those combined effects that are more challenging to replicate in the lab, and that's what we really get out of the harvested materials.

So that's what ultimately makes them so valuable. It allows us to assess those things that are very challenging to accurately recreate in the lab. And depending on the mechanism, we get an understanding if these combined effects are important or not.

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

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

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

feedback from stakeholders.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

VICE CHAIR KIRCHNER: This is probably not a quick one. You said you had a model for just about everything. Where's the feedback loop in all of this? In RES you get data. Have you been able to measurably improve your models, particularly with regard to age and/or fluence?

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

VICE CHAIR KIRCHNER: Yeah, probably for

Rob.

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

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

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

There was some initial screening models that were developed by industry and they didn't account for all the different failure modes that they could actually, those bolts would experience, so once they started seeing some operating experience and then they did -- they pulled bolts, they did root cause analyses. They were able with that additional information to go back and update their models, try to account for these new failure mechanisms.

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

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

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

MR. HISER: And it depends on the models. You know, the model is relevant to the Zorita experience, but more empiricals, so now it's how are we layering, how are we analyzing prior experimental data to this new experimental data and, you know, and weighing each of those?

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

MEMBER SUNSERI: Anything else?

(No audible response.)

MEMBER SUNSERI: All right, I guess I'll

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

(No audible response.)

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

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

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

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

Update on NRC Materials Harvesting Activities

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

October 6, 2022

ACRS Briefing

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

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

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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	• In-situ and in-service data for model verification • In-situ NDE • Mechanical and microstructural properties characterization • Benchmark structural damage • Potential further irradiation	• 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			Internals Bolts			Core Shroud / Barrel Welds		
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	

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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

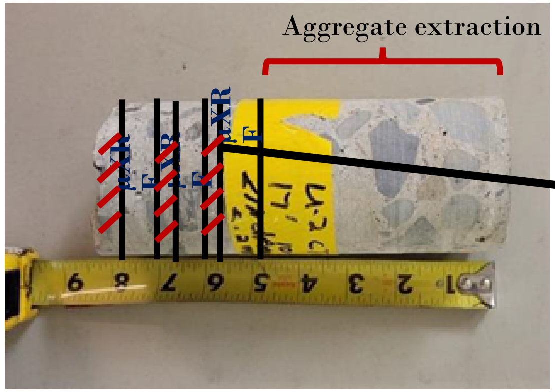
- Recent and current activities:
  - Harvested unirradiated concrete from San Onofre Nuclear Generating Station (SONGS) 2 to evaluate its susceptibility to irradiation (RIL 2022-07)
    - Based on mineralogy and irradiation level, irradiated concrete from SONGS would be a valuable opportunity to study irradiation-assisted concrete degradation
    - Obtained from SCE available plant documents, reports, drawings and concrete specifications
    - Drafted potential research plan

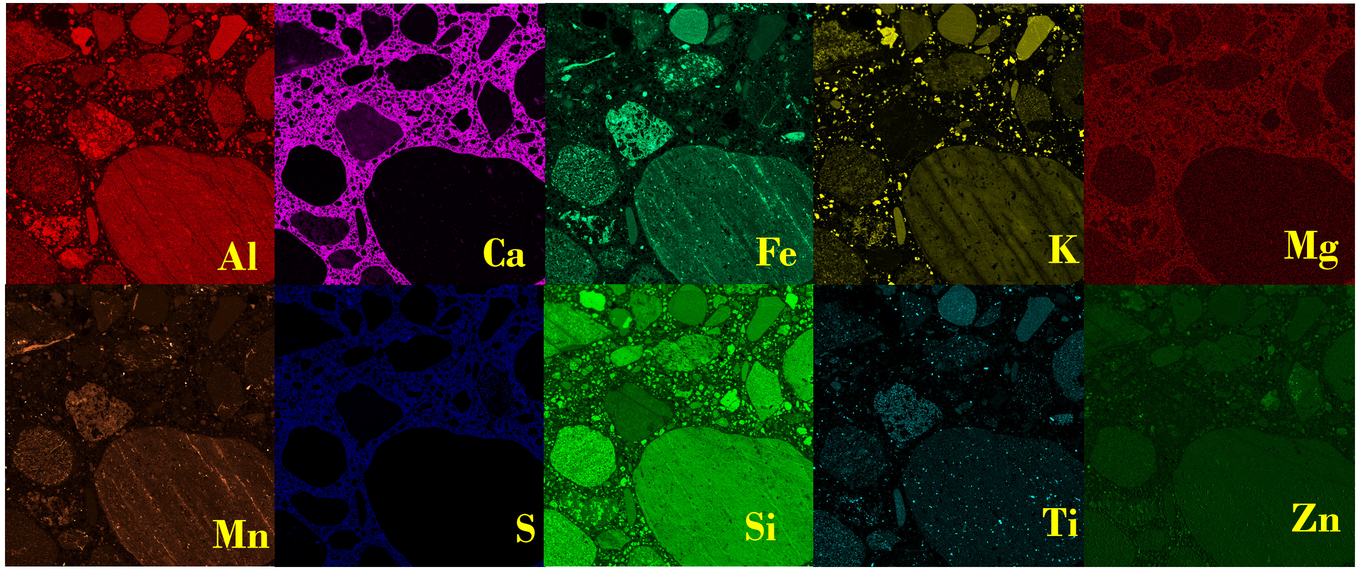
- Actively pursuing opportunity to harvest irradiated concrete to improve understanding of irradiation effects on concrete performance with harvest and research scope to include:
  - Harvest irradiated concrete from biological shield structures
  - In-situ testing and NDE
  - Laboratory research (mechanical 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, µXRF, petrography, XRD, SEM

3 slices were cut for petrography and µXRF





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

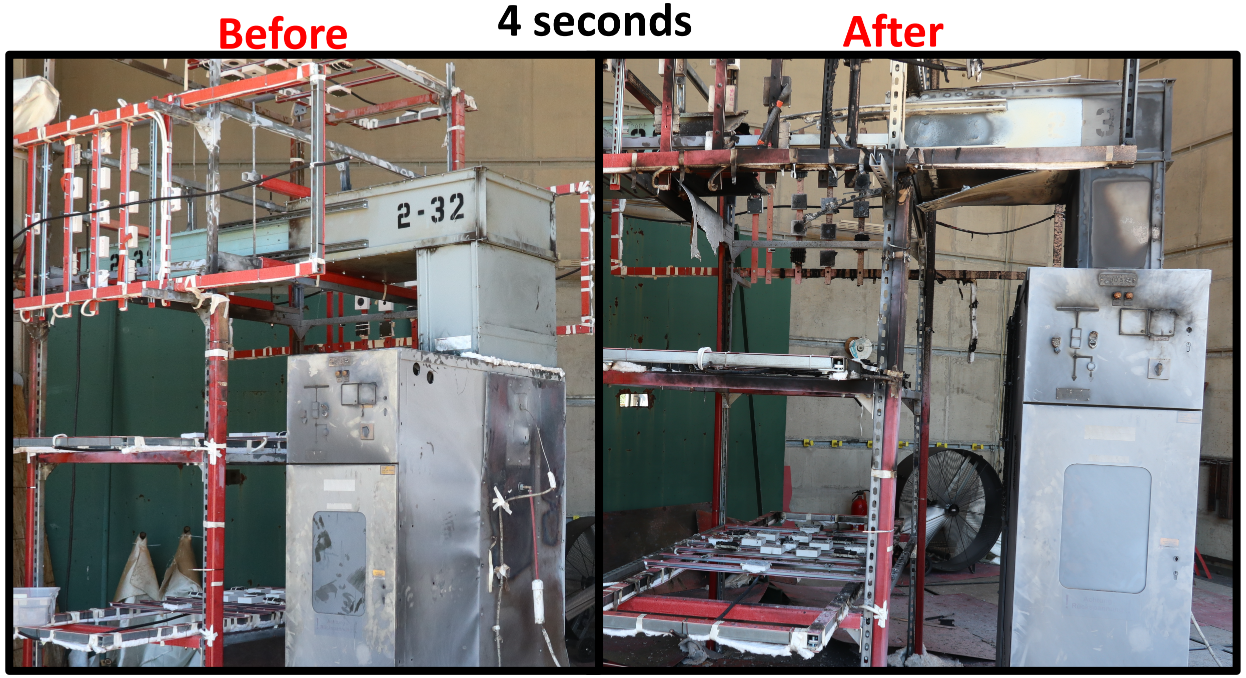
- Seeking opportunities to acquire and study aged electrical cables to determine if fire resistance is decreased after aging

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 access 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
- μXRF 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…

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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.
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6. D.E. McCabe, et al. *Evaluation of WF-70 Weld Metal From the Midland Unit 1 Reactor Vessel*, **NUREG/CR-5736** (ORNL/TM-13748), U.S. Nuclear Regulatory Commission, November 2000.
7. A.B. Johnson, Jr., S.K. Sundaram, F.A. Garner, *Program Plan for Acquiring and Examining Naturally Aged Materials and Components for Nuclear Reactors*, **PNNL-13930**, Pacific Northwest National Laboratory, December 2001. (Prepared for the U.S. Department of Energy).
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10. S.E. Cumblidge, et al. *Evaluation of Ultrasonic Time-of-Flight Diffraction Data for Selected Control Rod Drive Nozzles from Davis Besse Nuclear Power Plant*, **PNNL-19362**, Pacific Northwest National Laboratory, April 2011.
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