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July 8, 2022

MEMORANDUM TO: Matthew Hiser, Chief (acting)
Materials Engineering Branch
Division of Engineering
Office of Nuclear Regulatory Research

FROM: Jeffrey Poehler, Sr. Materials Engineer */RA/*
Reactor Engineering Branch
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SUBJECT: SUMMARY OF JUNE 27, 2022, PUBLIC MEETING ON
STATUS OF NRC HARVESTING ACTIVITIES

On June 27, 2022, the Nuclear Regulatory Commission (NRC) staff held a public meeting on the Status of NRC Harvesting Activities. The meeting was an Observation Meeting at which attendees had an opportunity to observe the NRC performing its regulatory function or discussing regulatory issues. Members of the public had the opportunity to ask questions about the issues discussed following the business portion of the meeting; however, the NRC was not actively soliciting comments towards regulatory decisions at this meeting. The meeting featured presentations by the NRC staff, several domestic and international organizations involved in material harvesting activities including the Electric Power Research Institute (EPRI), two U.S. Department of Energy (DOE)-sponsored programs, Studsvik, and Vattenfall, and by the public interest group Beyond Nuclear. All the presentations from the meeting are contained in Agencywide Document Access and Management Systems (ADAMS) package number [ML22178A155](#). The NRC staff allowed brief clarifying questions after each presentation. A list of the meeting participants is enclosed.

Opening Remarks

Louise Lund, Director of the Division of Engineering in the Office of Nuclear Regulatory Research provided opening remarks for the meeting. She first welcomed those attending, and especially recognized the presenters from EPRI, Idaho National Laboratory (INL), Oak Ridge National Laboratory (ORNL), Studsvik, Vattenfall, and Beyond Nuclear. Ms. Lund then described the purpose of the meeting and emphasized several points:

1. Harvesting is a broad topic that spans the full spectrum of nuclear power plant materials, components, and structures;
2. The NRC has adopted a proactive harvesting strategy;

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3. While harvesting can be an effective tool for better understanding age-related degradation, many effective aging management strategies are based on information sources other than harvesting; and,
4. Nuclear power plant license renewal applicants bear responsibility for determining the aging management strategies that they will propose to pursue to comply with 10 CFR Part 54.

Presentations

NRC Staff

The first NRC presentation by Dr. Robert Tregoning (ML22178A179) provided an overview and historical perspective on harvesting. In his presentation, Dr. Tregoning defined harvesting as “removal of materials, components, or structures from a commercial nuclear power plant (NPP) for the purpose of performing subsequent evaluations.” Harvesting can occur pre-service (to understand initial performance or characteristics), during service (from materials, components, or structures removed from service prematurely) or post-service (to evaluate performance at the end of the service life). This presentation emphasized that nuclear stakeholders have actively employed harvesting since the inception of commercial nuclear power plant operation to better understand the performance of important materials, components and structures, and that knowledge gained through harvesting can support effective aging management. Dr. Tregoning described some harvesting success stories from a regulatory perspective, including use of data from harvested materials in developing the Generic Aging Lessons Learned (GALL) Report for license renewal guidance, the alternate pressurized thermal shock rule (10 CFR 50.61a), and confirmation of inspection frequencies for reactor pressure vessel head penetrations. He also noted we are entering a new era where the harvesting supply is greater than demand due to the large number of decommissioning plants.

The second NRC presentation, by Mr. Matthew Hiser (ML22178A183), addressed NRC’s harvesting strategy, coordination, and activities. Mr. Hiser indicated that the NRC’s current harvesting objectives focus on materials aging during long-term operation. Since 2015, NRC has adopted a more proactive strategy with respect to harvesting due to the significant number of plants entering the decommissioning process, which has led to a greater supply of harvesting opportunities. Mr. Hiser described the harvesting prioritization criteria, which are criticalness of the technical issue addressed, importance of harvested materials over laboratory aging, applicability to the US operating fleet, and regulatory considerations related to inspection and AMPs. Mr. Hiser gave examples of high priority materials and components, such as high fluence stainless steel base metal and welds from reactor internals (useful to inform inspection scope), and irradiated concrete (useful to benchmark aging models for concrete). NRC has also catalogued previously harvested materials. Mr. Hiser also emphasized the importance of coordination with potential partners. Going forward, NRC will continue to update its harvesting prioritization, and will pursue harvesting opportunities in accordance with its harvesting strategy.

EPRI

Mr. Frank Gift presented EPRI’s perspective on harvesting (ML22181B126). EPRI’s presentation emphasized the value and relevance of harvesting and described some of its past and present harvesting activities and lessons learned. Mr. Gift explained how harvesting supports EPRI’s Materials Research Focus areas including reactor internals, stainless steel alloys, nickel based alloys, and low alloy steel (reactor pressure vessel embrittlement). Mr. Gift

also discussed past and current EPRI activities related to harvesting electrical cables and concrete. Mr. Gift detailed EPRI's various harvesting strategies, including in-situ inspection, laboratory exams, and additional aging of harvested samples. Additional aging could involve additional neutron irradiation of harvested materials at research reactors, or reinsertion into surveillance capsules, or longer thermal aging to initiate microstructural response.

EPRI is also collaborating with other organizations and projects, such as the Studsvik Material Integrity Life Extension (SMILE) Project, and the Sherlock program involving the Cruas, Unit 4 steam generator, as well as pursuing its own independent research. EPRI also provides consulting to other programs such as the Kori, Unit 1, (Korea) Decommissioning and Harvesting Program and is monitoring DOE and NRC harvesting activities. Key messages from Mr. Gift's presentation include that 1) EPRI continues to harvest materials to support age-related materials degradation studies for long-term operation; 2) Materials issue programs, electrical/instrumentation and control programs, and concrete nondestructive evaluation programs at EPRI have unique needs but EPRI has learned considerably from Zorita and Crystal River Harvesting Projects; 3) New projects with Ringhals, Indian Point, Cruas and others will deliver continued benefit to EPRI research programs in the years ahead.

International

Ms. Sofia Bjornsson and Mr. Martin Bjurman from Studsvik (Sweden) presented an overview of the SMILE Project (ML22178A181), which is supported by an international consortium that is harvesting materials from several decommissioning plants in Sweden. The SMILE project will occur over five years from 2021-2025 and is supported by organizations from eight countries. The main objective is to provide critical data and mechanistic understanding of materials aging mechanisms in support of plant aging management, life extension programs and operating license renewals. The main focus areas of study are reactor pressure vessel (RPV) low alloy steel irradiation and thermal embrittlement, stainless steel core support structures and embrittlement, and austenitic pressure boundary alloys. Some materials of note to be harvested from plants with more than 40 years of operation include highly irradiated wrought stainless steel and weld metal from reactor internals, Alloy 690 tubing from the world's second oldest replacement steam generator and Alloy 52 weld metal from the world's oldest replacement RPV head, RPV steel from very low dose to very high dose, and bottom mounted instrumentation nozzles.

Mr. Henric Lidberg from Vattenfall (Sweden) presented Vattenfall's perspective on harvesting as the owner of most of the commercial nuclear reactors in Sweden (ML22180A090), including how testing of harvested materials informs its aging management of its operating reactors. Swedish nuclear power plants have no firm licensing period, with operation contingent on an acceptable periodic safety review on a ten-year interval. Vattenfall currently plans to operate several units for 60 years. Areas of interest to secure this long-term operation include RPV low-alloy steel irradiation and thermal embrittlement, reactor internals, and structures. Mr. Lidberg indicated that harvested materials can provide benchmarking to available data generated in accelerated tests. Mr. Lidberg indicated that there is high interest from the perspective of the Ringhals plant in irradiated stainless steel components, particularly with respect to stainless steel welds and the possibility of formation of voids at high doses. In summary, Mr. Lidberg noted that 1) Harvesting materials closes gaps by getting more and qualitative data; 2) Extractions and analyses should be driven by needs/gaps; 3) Extractions and analyses should be made in collaboration and increase the common knowledge.

DOE

Dr. Tom Rosseel from Oak Ridge National Laboratory (ORNL) described how the Light Water Reactor Sustainability (LWRS) Program seeks to support long-term operation of the current light-water reactor fleet and uses materials harvesting as one strategy, among several, to achieve this goal (ML22178A156). Dr. Rosseel's presentation described past and current harvesting activities under the program, as well as challenges in performing harvesting. He described some past and ongoing harvesting activities under the LWRS program, including harvesting of electrical cables at Zion, Unit 1, instrumentation and control cables from Zion and Crystal River, Zion Unit 1 RPV materials, baffle-former bolts, and concrete from San Onofre Nuclear Generating Station (SONGS), Unit 2. Dr. Rosseel stressed that harvesting is an important component of understanding materials degradation. He also concluded that access to materials from active or decommissioned nuclear power plants provides an invaluable resource for issues in which there is limited operational data or experience for the purposes of informing relicensing decisions and aging management programs, for validating models as well as codes and standards, and to further develop the scientific basis for understanding and predicting long-term environmental degradation behavior.

Dr. Peng Xu from INL described how the Nuclear Science User Facilities (NSUF) program at INL manages the Nuclear Fuel and Materials Library (NFML) (ML22178A157). The NFML is an open archive of high-value irradiated fuels and material from test, commercial, and decommissioned power reactors, and provides a state-of-the-art facility for post-irradiation examination of harvested materials. NSUF participates in the Harvesting Work Group that includes individuals from DOE, NRC, EPRI, commercial nuclear power plants, and decommissioning organizations to develop a strategic approach to harvesting aged materials from US nuclear power plants and to identify areas of common interest. NSUF is also actively engaged with all stakeholders and actively pursuing harvesting activities to bring valuable irradiated materials from decommissioned commercial reactors to the NFML. An example of one of these harvesting activities is examination of donated type 304 stainless steel core shroud samples from a commercial nuclear power plant. These samples were harvested and donated by EPRI, owned by Southern Nuclear, and in the possession of BWX Technologies, Inc. A total of 133 samples were added to NFML as a result of this activity. The NFML now includes over 8,000 samples in total.

Beyond Nuclear

Mr. Paul Gunter from Beyond Nuclear gave a presentation focusing on concerns that the NRC is not pursuing enough harvesting to address perceived knowledge gaps related to materials aging (ML22178A182). Beyond Nuclear pointed to statements made in a draft technical letter report (PNNL-27120) by Pacific Northwest Nuclear Laboratory (PNNL) written under NRC contract to provide recommendations on a strategy for harvesting. The draft report contained several statements containing language such as "critical knowledge gaps," "technical gaps," and other statements to the effect that harvesting will likely "be required" to address these gaps. In his summary, Mr. Gunter's stated that the key takeaways in the public interest are 1) Prompt decommissioning is broadly favored compared to "SAFSTOR"¹, and the NRC should avoid more missed strategic opportunities to perform autopsies prior to burial and destruction of scientific evidence; 2) Strategic harvesting of "high priority" aged material samples must be planned and

¹ A method of decommissioning in which a nuclear facility is placed and maintained in a condition that allows the facility to be safely stored and subsequently decontaminated (i.e., deferred decontamination) to levels that permit release for unrestricted use.

coordinated with the stages of dismantlement; 3) Extreme license extensions cannot reasonably proceed absent verification and validation of the material science needed to close “high priority” technical knowledge gaps in age related degradation mechanism management; and 4) As industry currently benefits from recurring license extensions, Congress and the NRC should increase operating license fees to sufficiently fund strategic harvesting at decommissioning sites for laboratory analysis.

General Summary - Presentations

Common high-interest areas for harvesting among organizations participating in the meeting include irradiation assisted degradation of reactor internals, RPV neutron embrittlement, concrete aging due to irradiation and other effects, and aging of electrical cables. A common theme for the organizations involved in harvesting is the difficulty and complexity of harvesting materials from decommissioning plants, particularly for highly irradiated materials. However, all agree that harvesting can yield useful information to inform the aging management process.

Public Comments

In reference to the presentation by Mr. Gunter, the NRC staff noted that the version of PNNL-27120 report cited by Beyond Nuclear was an inadvertently released draft, and that the most current version of the report is Revision 1.

Mr. Gunter from Beyond Nuclear commented that in the mid-1990’s, there was a decision by the NRC to not pursue harvesting of several plants decommissioning at the time (i.e., Trojan, SONGS 1, Rancho Seco and Yankee Rowe), and that there was an opportunity for harvesting RPV material from Trojan after the RPV was at the disposal site. Subsequent to the meeting, Mr. Gunter provided a reference² for this decision. NRC staff added that it would search for, and provide, any additional publicly available information supporting the decision to not harvest materials from Trojan at the disposal site.

Other comments made by members of the public during the meeting addressed the following issues:

- There were missed opportunities for harvesting from plants that were decommissioning in the mid-1990’s due to the cited NRC director’s decision.
- Examples were provided of components at specific plants that should be harvested
- The need for harvesting of materials and components not inspectable by a condition monitoring program
- The reliability of condition monitoring for aging management of large structures or components.
- The lack of consideration of risk in harvesting prioritization, and that risk from external events and non-safety related components (e.g., flood seals) should be factored into harvesting prioritization.

² Yankee Atomic Electric Co., Sacramento Municipal Utility District, Portland General Electric Co., and Southern California Edison Co.; Receipt of a Petition for, and Issuance of, a Director’s Decision under 10 CFR 2.206,” U.S. NRC, Federal Register, Vol. 61, No. 121, June 21, 1996, pp. 31964 to 31966.

- Transparency of the process for determining what materials are harvested from decommissioning plants.
- The need for plant records to be preserved after plant shutdown to support harvesting.
- If the capability existed at the NSUF hot fuel examination facility to transfer fuel from one cask to another.

NRC staff responses explained that the effectiveness of condition monitoring is a principal consideration during harvesting prioritization. It was indicated by INL that the hot fuel facility can transfer fuel from a cask. Staff also stressed that the purpose of the meeting is discuss harvesting in general and not specific components associated with individual plant issues. However, the staff considers the generic value of such specific components when prioritizing harvesting opportunities from individual plants that are decommissioning.

Closing Remarks

Dr. Tregoning thanked the presenters and stressed that meeting participants heard from a wide variety of nuclear stakeholders including the NRC, nuclear industry as represented by EPRI, the DOE, an international nuclear power plant operator, the operating agent for an international harvesting project, and the public. Dr. Tregoning reiterated the following two thoughts from Ms. Lund's opening remarks that were common themes through the meeting presentations:

- Harvesting is a broad topic that spans the full spectrum of nuclear power plant materials, components, and structures, including irradiated components from decommissioning power plants. Irradiated materials harvesting efforts, in particular, are complex, costly, require long-range, flexible planning, and often are only possible through collaboration among multiple stakeholders.
- A proactive harvesting strategy is the preferred approach for managing these challenges. Such a strategy first identifies technical priorities that are best addressed through harvesting, explores possible opportunities for achieving those priorities, and then attempts to organize other interested stakeholders into a collective effort that satisfies each stakeholder's technical objective while optimally leveraging resources.

Enclosure

As stated

List of Attendees
June 27, 2022 Public Meeting on Status of NRC Harvesting Activities

Name	Affiliation
Matt Sunseri	ACRS
Ronald G. Ballinger	ACRS
Paul Gunter	Beyond Nuclear
Jana Bergman	Curtiss-Wright
Michael Keegan	Don't Waste Michigan
Hannah E. Pell	Energy Solutions
Tim Devik	Energy Solutions
Kyle Amberge	EPRI
Frank Gift	EPRI
Kelly A. Cunningham	INL
Peng Xu	INL
Alfred Meyer	Member of Public
Connie Kline	Member of Public
Don Safer	Member of Public
Jeff Mittman	Member of Public
John Pfabe	Member of Public
Kalene Walker	Member of Public
Michel Lee	Member of Public
Paul Blanch	Member of Public
Thomas Stokes	Member of Public
Tim Schopf	MPA Stuttgart
Lydiana Alvarado	NRC
Michael Benson	NRC
Steven Bloom	NRC
Julia Boeyink	NRC
Angie Buford	NRC
Mat Burton	NRC
Jesse Carlson	NRC
Robert Davis	NRC
Rhex Edwards	NRC
Carolyn Fairbanks	NRC
Eric Focht	NRC
Lauren Gibson	NRC
Kenneth Hamburger	NRC
Emma Haywood	NRC
Allen Hiser	NRC
Matthew Hiser	NRC
Joel Jenkins	NRC
Paul Klein	NRC
Louise Lund	NRC

Name	Affiliation
Gregory Makar	NRC
John McKirgan	NRC
James Medoff	NRC
Carol Moyer	NRC
Eric Palmer	NRC
Cory Parker	NRC
Jose Pires	NRC
Jeff Poehler	NRC
Pat Purtscher	NRC
David Rudland	NRC
Neil Sheehan	NRC
Madhumita Sircar	NRC
Gabe Taylor	NRC
Doug Tifft	NRC
Robert Tregoning	NRC
John Tsao	NRC
Christopher Tyree	NRC
Jenny Weil	NRC
Dan Widrevitz	NRC
On Yee	NRC
T.M. Rosseel	ORNL
Matthew Marzano	Senate - Environment and Public Works Committee
Geri Shapiro	Senator Gillibrand's Staff
Rich Janati	State of Pennsylvania
Mike Callahan	State of Pennsylvania
Lotta Nystrand	Studsvik
Martin Bjurman	Studsvik
Sofia Björnsson	Studsvik
Edwin Lyman	Union of Concerned Scientists
Henric Lidberg	Vattenfall

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PPurtscher, RES/DE/CMB
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JTsao, NRR/DNRL/NPHP
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