

## NRC's Long-Term Operation-Related Research

### Issue:

- As nuclear power plants (NPPs) age, the reactor structural components degrade due to exposure to high temperature, neutron irradiation, stress, and corrosive media.
- Understanding the causes and mitigation of degradation mechanisms is the basis for developing and revising aging management programs (AMPs) to ensure that the effects of aging on the functionality of structures and components will be managed to maintain the current licensing basis (CLB) such that there is an acceptable level of safety during the period of extended operation.
- The NRC Office of Nuclear Regulatory Research (RES), in cooperation with the U.S. Department of Energy's (DOE's) Light Water Reactor Sustainability (LWRS) program, identified key technical issues related to materials degradation in SSCs for operating periods from 60 to 80 years (NUREG/CR-7153, "Expanded Materials Degradation Assessment, Vols. 1-5") (ML14279A321).
  - The technical issues reviewed in NUREG/CR-7153 include: reactor pressure vessel (RPV) embrittlement, irradiation-assisted stress corrosion cracking of reactor internals, concrete structures and containment degradation, and electrical cable qualification and condition assessment to assess cable aging.
- Proposed industry innovations, such as plant automation, could aid the long-term operation (LTO) of the current fleet of NPPs but may require regulatory review and approval for certain aspects.

### NRC Key Messages:

- Licensees and applicants have the primary responsibility for providing the technical basis to support their safety analyses and applications for license renewal and other licensing actions. The NRC staff conducts confirmatory research to independently verify licensee data, determine safety margins, and reduce uncertainties.
- Aging management research continues, as needed in some targeted areas, to allow better understanding of SSC degradation for robust LTO. Although a rich research technical basis is available to support LTO, this targeted research will inform staff reviews of future licensing actions and will support the technical basis for updating regulatory guidance in the future, and provide insights that allow licensees to update their AMPs as applicable.

### NRC Status and Next Steps:

- The NRC's subsequent license renewal (SLR) guidance documents published in July 2017—"Standard Review Plan for Review of Subsequent License Renewal Applications for Nuclear Power Plants" (NUREG-2192) (ML17188A158) and "Generic Aging Lessons Learned for Subsequent License Renewal (GALL-SLR) Report" (NUREG-2191) (ML17187A031)—incorporated changes informed by NRC-led cooperative research that addressed the key technical issues discussed in NUREG/CR-7153 for LTO to 80 years. The NRC also audited licensee AMPs for effectiveness and used these results to inform the guidance. The GALL-SLR and SRP-SLR are considered living documents, with updates provided by Interim Staff Guidance documents.
  - SLR-ISG-2020-01- PWRVI (ML20217L203)
  - SLR-ISG-2021-02-MECHANICAL (ML20181A434)
  - SLR-ISG-2021-03-STRUCTURES (ML20181A381)
  - SLR-ISG-2021-04-ELECTRICAL (ML20181A395)

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- Licensees have submitted SLR applications for ten reactors across five sites. The NRC staff has, so far, issued subsequent renewed licenses to Turkey Point Units 3 and 4 and Peach Bottom Units 2 and 3. The NRC staff continues to review the applications for the remaining reactors.
- LTO research will expand knowledge and confirm aging projections by:
  - Continuing to trend RPV properties
  - Continuing to assess properties of RPV internals at medium and high fluence
  - Evaluating the effects of long-term irradiation of concrete and methods for inspection
  - Assessing cable condition monitoring techniques and confirming qualification for performance in harsh environments
- The NRC staff continues to cooperate with DOE and the Electric Power Research Institute (EPRI) to align research priorities and maintain transparency in addressing remaining technical issues for LTO.
- The NRC, DOE, and EPRI use joint research roadmaps to communicate about cooperative and complementary research on aging management for LTO. These roadmaps are used as planning tools and to aid communication among the counterpart organizations to facilitate understanding of each entity's priorities.
- In accordance with each plant's license, the NRC staff will evaluate the safety impacts of proposed plant modernization technologies intended to increase plant reliability and cost-effectiveness.
  - Examples of the technologies proposed by the nuclear industry include: wireless connectivity, digital I&C upgrades, condition-based maintenance, remote monitoring & diagnostics, mobile work execution, automated chemistry & radiological monitoring, advanced NDE, physical security & emergency preparedness.

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