

# Long Term Operation NRC's Current Research on Concrete

U.S. Nuclear Regulatory Commission  
Office of Nuclear Regulatory Research  
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# Outline

## Regulatory Research for Long-Term Operation (LTO)

### Radiation Effects on Structures

- NRC's Confirmatory Research
- NRC-DOE-EPRI Joint Research Activities
- Harvesting Opportunities for Irradiated Concrete
- Other External Collaborations
- Summary

# Regulatory Research for LTO

## RES Mission

To provide technical advice, tools, and information for meeting the NRC's mission, including resolving safety and security issues, making regulatory decisions, and promulgating regulations and guidance.

## Objectives

- Enhance knowledge-to support reviewing license renewal applications
- Reduce uncertainty
- Provide technical bases for generic guidance (vs. plant-specific)
- Inform future revisions to SLR guidance (e.g., Interim Staff Guidance developments)
- Continue focus on aging management for systems, structures and components into LTO

# NRC's Confirmatory Research (1/3)

## Research Drivers

- NUREG/CR-7153 (EMDA Report) Vol 4, "Aging of Concrete and Civil Structures," identifies radiation effects on concrete as low-knowledge but high significance
- Knowledge has improved but further research can help address future technical issues and uncertainties
- Structures exposed to radiation are inaccessible for inspection.
- "Be Ready" for advanced/newer technologies and regulatory implications

# NRC's Confirmatory Research (2/3)

## NRC's Confirmatory Research Activities

- State of knowledge on radiation-induced concrete degradation and its implications on NPP structures, Argonne National Laboratory (ANL), Report February 2020 (NUREG/CR to be published)
- Review and feedback on selected EPRI reports (2017-2018)
- Radiation evaluation methodology for concrete structures, Oak Ridge National Laboratory (ORNL), Report in June 2020, NUREG/CR to be published
- Development of theoretical models to predict properties of radiation damaged concrete, ANL and the University of Colorado, Report in December 2020
- In-house assessment of damage extension and structural capacity (2019 – 2023)

# NRC's Confirmatory Research (3/3)

## NRC's Confirmatory Research Activities

Perform limited testing, modeling and numerical simulations of irradiated concrete behavior (including concrete-steel bonding) and develop methodology for structural evaluation at ORNL (2019 – 2023)

- Develop and conduct an experimental scoping study at LVR-15, Czech Republic to characterize the effects of irradiation on the bond properties of steel rebar in concrete
- Develop and validate a modeling methodology to assess the effects of irradiation on reinforced concrete biological shields in light water reactors
- Study size effect and develop a upscaling modeling strategy to verify applicability and significance of small-scale accelerated experimental data at the structural level
- Investigate rate effect (JEEP-II vs. LVR-15)

# NRC-DOE-EPRI Joint Research

## Future focus areas

- Modeling of concrete damage mechanisms
  - Confinement effects, steel-concrete bonding, cyclic loads, rate effects, scale effects (small specimen to structural scale), creep effects.
- Opportunities for harvesting and testing of concrete samples from decommissioned nuclear power plants for confirmation of regulatory research
- Methods for inspection/monitoring for the bio-shield and reactor vessel support structures

# Harvesting Opportunities for Irradiated Concrete

- Ex-plant irradiated concrete is extremely valuable for confirmatory testing and for reducing uncertainties (concrete has been exposed to actual in-service plant operating conditions)
- Opportunity for harvesting irradiated concrete from the San Onofre Nuclear Generating Station (SONGS) has re-emerged
- NRC, ORNL, and EPRI technical coordination and planning for harvesting and research has started



# External Collaborations

- Memoranda of Understanding with DOE and EPRI
- Bilateral and multilateral agreements
- International Committee on Irradiated Concrete
- Strategic international partnerships
  - France, Japan, Canada
- IAEA
  - IGALL, SALTO, TSO
- NEA/CSNI/WGIAGE
  - VERCORS
  - ASCET



# Summary

- NRC/RES will continue collaboration with DOE and EPRI on concrete research to reduce regulatory uncertainty.
- Leveraging stakeholders helps facilitate regulatory research supporting safety during LTO.
- Regulatory research supporting operational safety will continue to support reviews of license renewal applications, revision of aging management guidance and associated regulatory documents.