Long Term Operation
NRC's Current Research on Concrete

U.S. Nuclear Regulatory Commission
Office of Nuclear Regulatory Research
Division of Engineering

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

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

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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

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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)

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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.

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