

NRC Perspectives on Irradiated Concrete

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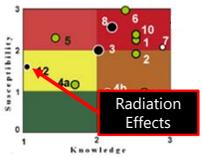
Overview

- Background
- Research Perspectives
- Licensing Perspectives



2

Background



Technical Concern:
 Expanded Material Degradation Assessment (EMDA) Report (NUREG/CR-7153) Vol 4, "Aging of Concrete and Civil Structures," identifies radiation effects on concrete as low-knowledge but high significance/susceptibility for SLR.

NRC Publications

- NUREG/CR-7171, "A Review of the Effects of Radiation on the Microstructure and Properties of Concretes Used in Nuclear Power Plants"
- NUREG/CR-7153 Vol. 4, "Aging of Concrete and Civil Structures"

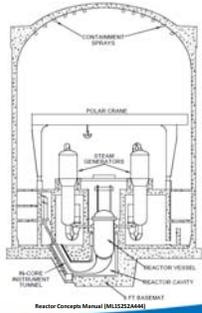
Commission Directive

- SECY-14-0016: the NRC staff is conducting a series of activities to prepare for review of subsequent license renewal (SLR) applications
- SRM to SECY-014-0016: staff directed to keep the Commission informed regarding progress on this issue



3

Research Perspectives:



- Reactor vessel generally supported under the inlet and / or outlet nozzles
- Nearest load-bearing concrete depends on the nozzle support design
- Basic Information for research and performance evaluation
 1. Neutron fluence and Gamma dose
 2. Plant configuration and structural details of reactor supports and bio-shield
 3. Concrete composition (aggregates, cement, grout, etc.), reinforcement and embedded steel supports
 4. Environment (temperature and humidity)
 5. Current Licensing Basis (CLB) design requirements (method, load combination, design codes)

Research Perspectives:



• Research Objectives

- Estimation of expected level of radiation (neutron $E > 0.1$ MeV and gamma) on concrete for the period of SLR (up to 80 years of operation) and propagation of radiation through concrete section
- Characterization of degradation due to radiation
- Structural significance for long-term operations
- Programmatic aspects for managing the aging effect

5

Research Perspectives:



• Engagements

- NRC is conducting confirmatory research
- NRC-DOE-EPRI Joint Research MOU
- NRC-NRA (Japan) bi-lateral Research MOU, received experimental data recently complete by NRAJ
- Participating in International Committee on Irradiated Concrete (ICIC)

6

Licensing Perspectives



- Generic Aging Lessons Learned Report and Standard Review Plan for License Renewal updated for Subsequent License Renewal (GALL-SLR and SRP-SLR)
 - Aging effects of reduction of strength and loss of mechanical properties due to irradiation (and radiation induced heating)
- *Further Evaluation* is recommended of a plant-specific program to manage these aging effects for PWRs and BWRs

7

Licensing Perspectives



From SRP-SLR Section 3.5.2.2.2.6:

“Further evaluation is recommended of a plant-specific program...if the estimated (*calculated*) fluence levels or irradiation dose received by any portion of the concrete from neutron (fluence cutoff energy $E > 0.1$ MeV) or gamma radiation exceeds the respective threshold level [1×10^{19} neutrons/cm² and 1×10^8 Gy] during the subsequent PEO or if plant-specific OE of concrete irradiation degradation exists that may impact intended functions.”

Expectation:

Plant-Specific
Fluence
Calculation
+
Plant-Specific
Operating
Experience
Review

8

Licensing Perspectives



Fluence levels < Threshold limits
AND
No OE impacting intended
functions



Further Evaluation
criteria satisfied

Fluence levels > Threshold limits
OR
OE impacting intended
functions



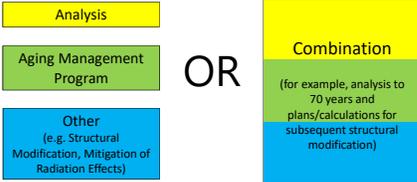
Address the aging
effect of loss of
strength of concrete
structures due to
irradiation for
subsequent period of
extended operation

9

Licensing Perspectives



Addressing Further Evaluation Criteria for irradiated concrete aging effect
(plants that exceed fluence threshold)



*Applicant must demonstrate continued ability of structures to perform intended functions through the subsequent period of extended operation at the time of the SLRA submission

10

Licensing Perspectives



Key Expectations for SLR (if consistent with GALL-SLR)

- Disposition of the irradiated concrete Further Evaluation should be based on a plant-specific fluence calculation, regardless of plant design
- To date, NRC has not approved any topical report as bounding of degradation due to irradiation
 - As such, SLR applicants should not use topical reports solely to disposition the aging effects related to irradiation of concrete
- If Analysis is used to address the further evaluation criteria:
 - Analyses should consider plant-specific configuration, loads and load combinations, or justify a bounding case
 - Justifications of proposed modeling assumptions should be provided
 - Analyses should consider combined effects of environmental factors as applicable

11

Today's Presentations



<p>EPRI's Long Term Operation Research on the Effects of Radiation on Concrete Biological Shields</p> <p>Emma Wong Sr. Technical Leader, Electric Power Research Institute</p>	<p>Irradiation Effects on Concrete Strength</p> <p>Masayoshi Kojima Chief Researcher Nuclear Regulatory Authority, Japan</p>
<p>Radiation Effects on Concrete Structures: Structural Performance and Materials Degradation</p> <p>Bruce Biwer Program Manager Nuclear Regulatory Programs Argonne National Laboratory</p>	<p>Effects of Irradiation on Concrete: Mechanisms and Significance</p> <p>Yann Le Pape, Sr. Scientist, Oak Ridge National Laboratory</p>

12
