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NRC's Research Perspectives on Irradiated Concrete

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Overview

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- Objectives and Outcome
- Engagement
- Plant Specific Information
- Additional Knowledge Development

Research Perspectives

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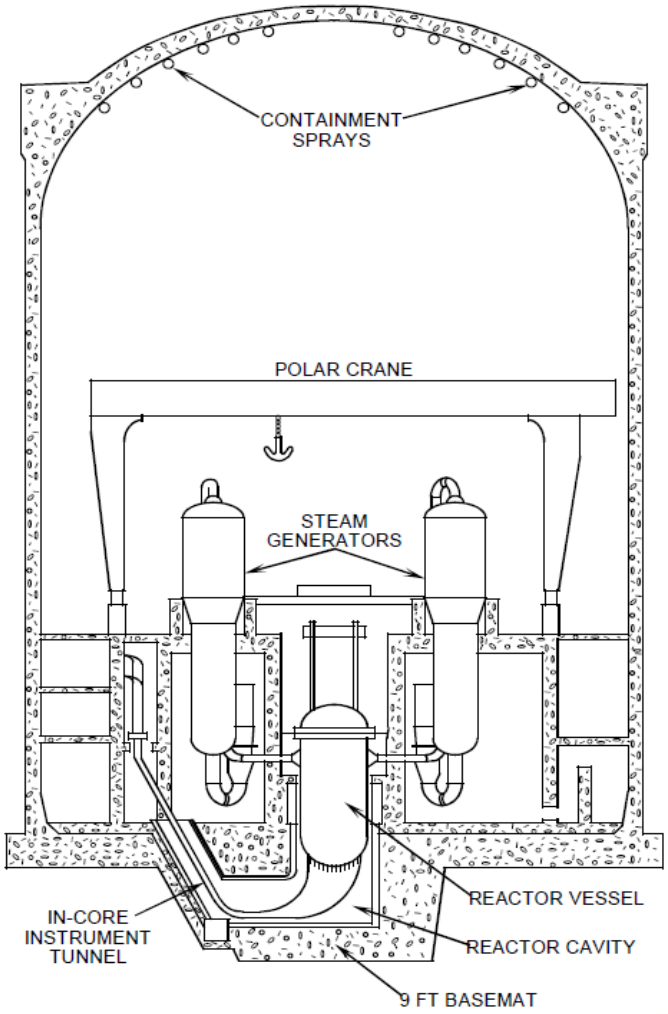

Reactor Concepts Manual (ML15252A444)

- Reactor pressure vessel (RPV) generally supported under the inlet and/or outlet nozzles
- Nearest load-bearing concrete depends on the nozzle support design
- RPV supported on concrete bioshield (CBS)
- RPV supported on steel columns and horizontal steel frame anchored to CBS for lateral load transfer
- Other safety related concrete structure and components close to RPV

Research Perspectives

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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
- Characterization of concrete damage depth under structural constraints
- Structural significance for long-term operations considering current licensing basis design
- Programmatic aspects for managing the aging effects

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Outcome

- Approaches for confirmatory review of industry research to assess structural performance for the structures exposed to high radiation
- Technical bases to support updating regulatory guidance for structures exposed to high irradiation for operating life up to 80 years (SLR).

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- **Engagements**
  - NRC is conducting confirmatory research
  - NRC-DOE-EPRI joint research MOU and roadmap
  - NRC-NRA (Japan) bi-lateral research MOU – NRC received experimental data from recently completed NRAJ research
  - Participating in International Committee on Irradiated Concrete (ICIC)

Estimated 80-Year Neutron Fluence (E > 0.1 MeV) on Concrete

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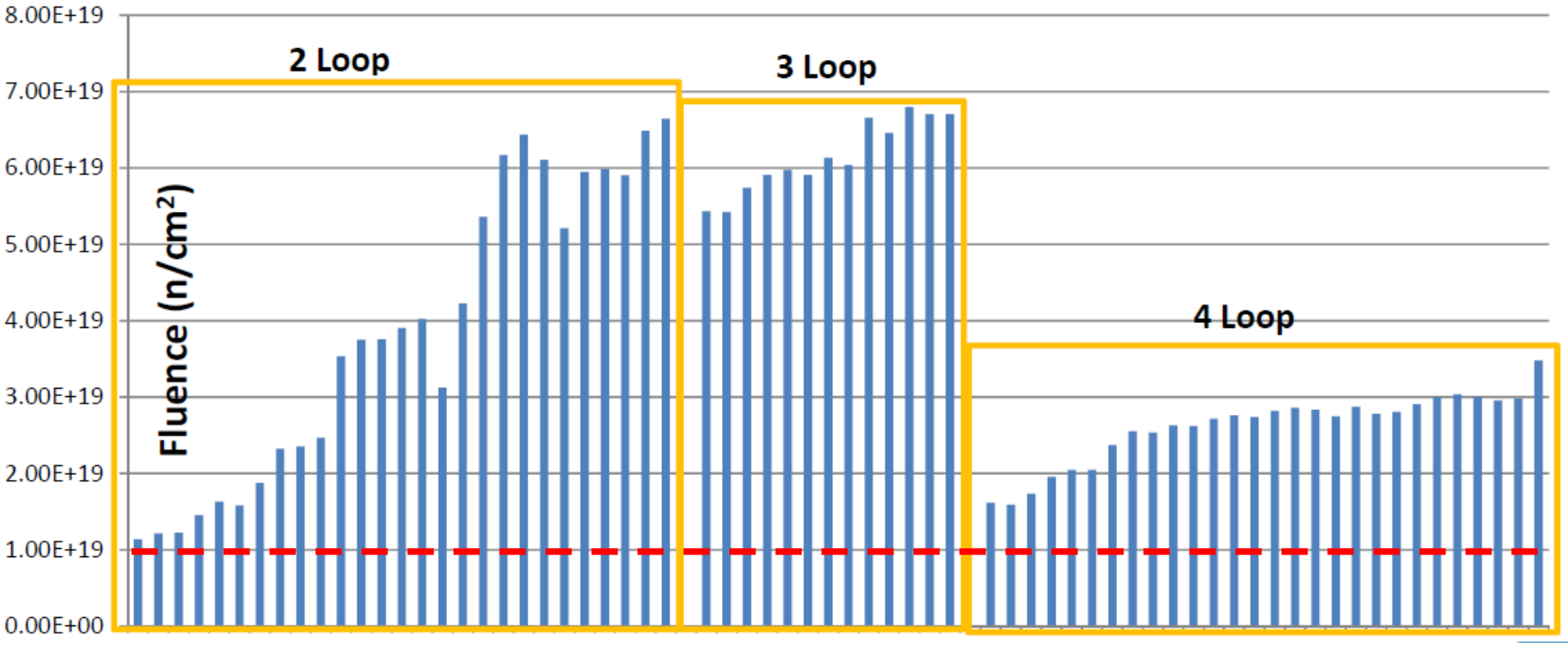

Estimated 80 Year Neutron Fluence (E >0.1 MeV) at Outer RPV (Inner face of concrete is about 10% less).

Source: ORNL/TM-2018/769

Plant-Specific Information to Develop Basic Understanding

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- Current neutron fluence and gamma dose information
- Plant configuration and structural details of RPV supports and bioshield wall
- Concrete composition (aggregates, cement, grout, etc.), reinforcement and supports anchorage
- Environment (temperature and humidity)
- CBS liner and attachment
- Current Licensing Basis design requirements (method, load combination, design codes)
- Inspection and monitoring methods

Plant-Specific Information to Develop Basic Understanding

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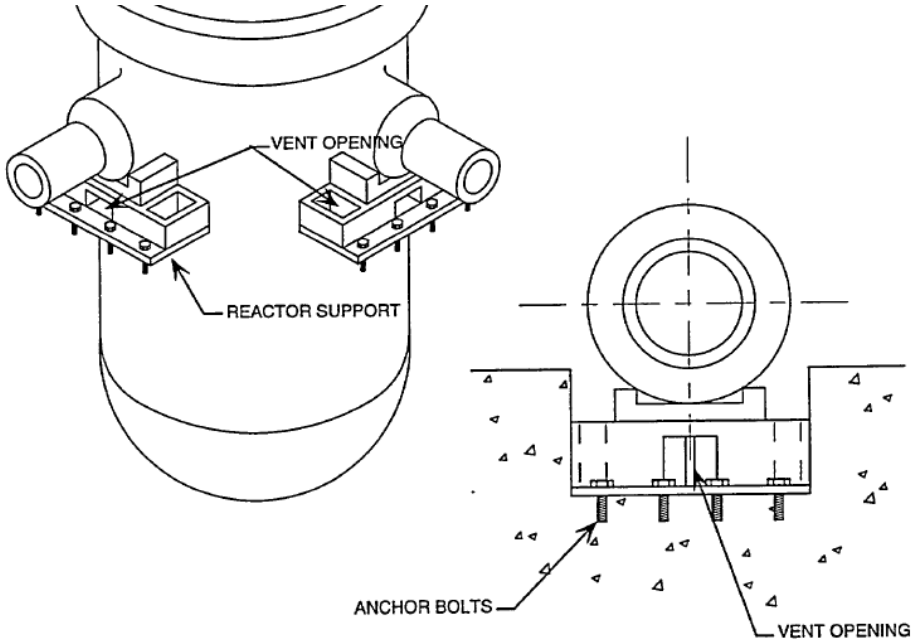
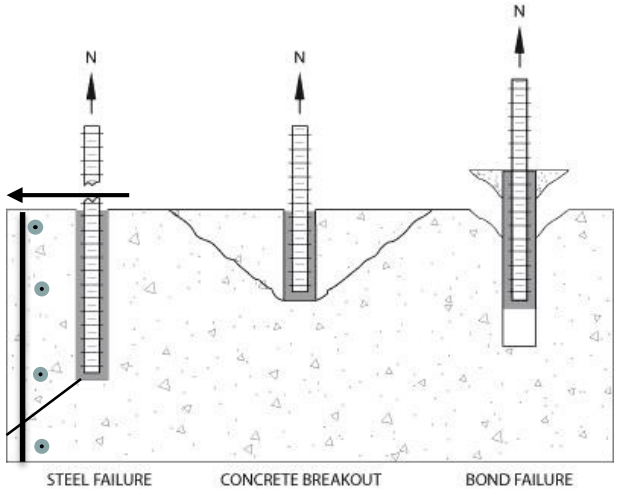
- Support details
- Local design considerations - concrete, rebar, anchorages
- Characterization of load-resisting mechanisms (for example, steel-concrete bond strength)





Source: WCAP-14422 Rev. 2-A

Additional Knowledge Development

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Irradiated Steel-Concrete Bond Strength [Significant]

- Possible loss of bond due to the irradiation-induced damage of concrete around rebars and support anchorages

Rate Effects

- Require concrete harvested from decommissioned LWR NPPs
  - at high dose, i.e., > 10^{19} n.cm^{-2} @ E > 0.1 MeV
  - w/ high silica content aggregate

  No relevant harvesting opportunity as of today.
  Likely source San Onofre, Keewaunee

Examination of In-Situ Damage, Monitoring, and Aging Management approaches

Irradiated Concrete Creep

- Need for experimental data. Concrete creep may affect irradiation-induced cracking

Irradiation-Assisted Alkali-Silica Reaction

- Irradiation-induced amorphization increases the dissolution rate of aggregates

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QUESTIONS?