Spent Fuel Pool
Neutron Absorbing Material Degradation

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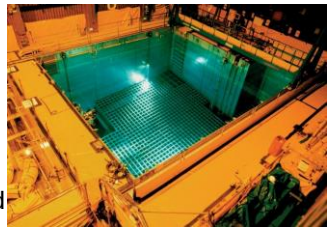
Overview

- Safety Significance
- Material Types
- Experience
- Staff Observations
- NRC Questions
- NRC Actions
- NRC Path Forward
- Timeline
- Summary



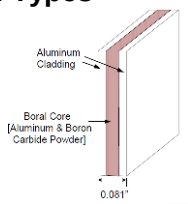
Picture: Spent Fuel Pool

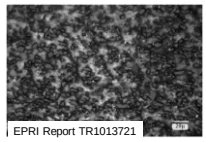
Safety Significance

- Prevent the occurrence of any inadvertent criticality events in the SFP
- Neutron absorbing materials have a direct impact on safety
  - Unidentified and unmitigated degradation poses a criticality and safety concern
  - Challenges compliance with NRC subcriticality requirements: 10 CFR 50.68 and GDC 62
- NRC staff has identified this issue as potentially safety significant

Material Types

- Most popular at US plants
  - Aluminum Boron Carbide Cermet
    - BORAL®
  - Non-metal Matrix Composites
    - Boraflex
    - Carborundum/Tetrabor®
  - Metal Matrix Composites
    - METAMIC®
- New Metal Matrix Composites
  - Bortec®
  - Alcan Composite





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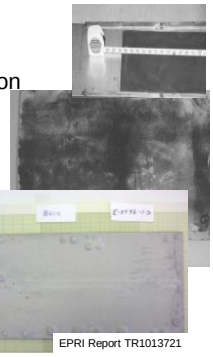
Pictures: BORAL® cross-section and Bortec® micrograph

Experience

- Boraflex
  - Silica polymer matrix degradation
  - Gaps, cracks, shrinkage
  - INs: 87-43, 93-70, 95-38
  - GL 96-04: Maintain 5% margin
- BORAL®
  - Blistering & bulging
  - IN 83-29, IN 09-26



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Pictures: In-service shrinkage and Boraflex removed from Spent Fuel Racks and Boral Blistering

Experience

- Carborundum
  - Stuck fuel assemblies
  - Significant amounts of degradation
  - IN 09-26

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- Monitoring programs
  - Ineffective implementation of corrective actions
  - Ineffective in identifying and mitigating degradation
  - IN 12-13

Picture: Carborundum microphotograph and example of Boral blister and bulge

NRC Observations

- Surveillance program important to detect onset of degradation
- Effectiveness of surveillance monitoring programs impact management of the SFP
- Effective operating experience evaluation can lead to early identification
- Unknown degradation mechanisms and rates could result in reduced subcriticality margins.

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NRC Questions

- Materials in each SFP and monitoring method
- Monitoring and mitigating the material degradation
- Degree of accuracy of in-situ neutron attenuation measurements
- Surveillance intervals to monitor degradation
- Material degradation affect on the criticality analysis

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NRC Actions

- IN 09-26, LR-ISG 2009-01, update to GALL (NUREG 1801 Rev 2), and IN 12-13
- NRC evaluating material degradation mechanisms, surveillance techniques, and predictive modeling
  - Literature knowledge base
  - Confirmatory research on the surveillance methodology
  - Confirmatory research on the surveillance interval adequacy

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Knowledge Base

- Current NRC state of knowledge
  - Commercial and decommissioned SFPs
  - Lists materials in each SFP
  - Periodically updated
- Issued public
  - Technical Letter Report: ML113550241
  - Spreadsheet: ML121090500
- Many gaps in information
  - Material and configuration in the SFP
  - Use in the criticality analysis of record

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Surveillance Methodologies

- Visual inspection
- Coupon monitoring
  - Representative of the rack panel material
  - Test methods/procedures
- Predictive modeling methodology
  - RACKLIFE
- In-situ testing methodology
  - Blackness testing
  - BADGER testing
- Other methods

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Surveillance Methodologies

- Boraflex methodologies (predictive code and in-situ method) examined
- Technical Letter Reports (TLRs) published
  - TLR on Boraflex, RACKLIFE, and BADGER methodologies: ML12216A307
  - TLR on BADGER tool: ML12254A064
- BADGER report pertains to all neutron absorbing materials

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Surveillance Frequencies

- Material degradation mechanisms and rate
- Frequency acceleration/deceleration
- Indicators of degradation between surveillances

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Criticality Aspects

- Degradation of the material's potential affect on the criticality analysis of record
  - Loss of material – neutron absorbing capability
  - Deformation – blistering, bulging, pitting, warping
  - Gaps, cracks, shrinkage, densification
  - Voids
  - Structural integrity
  - Wear/mechanical damage

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NRC Path Forward

- Phenolic resins report
- Cermet research
- Metal matrix composite research
- Borated stainless steel research
- Coupon methodology
- Potential Generic Communication
  - Work in progress
  - May be used to gather information
  - Determine if any additional NRC actions necessary

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Timeline

- Public Meeting on New/Future Materials – March 2013
- NEI Used Fuel Management Conference - May 2013
- Phenolic Resin TLR – Mid-2013
- Public Comment period on potential generic communication - Mid-2013

Summary

- Gaps in information and questions
- Additional dialogue with industry
- Additional research underway
- Regulatory guidance, as necessary
- Other generic communications, as necessary