

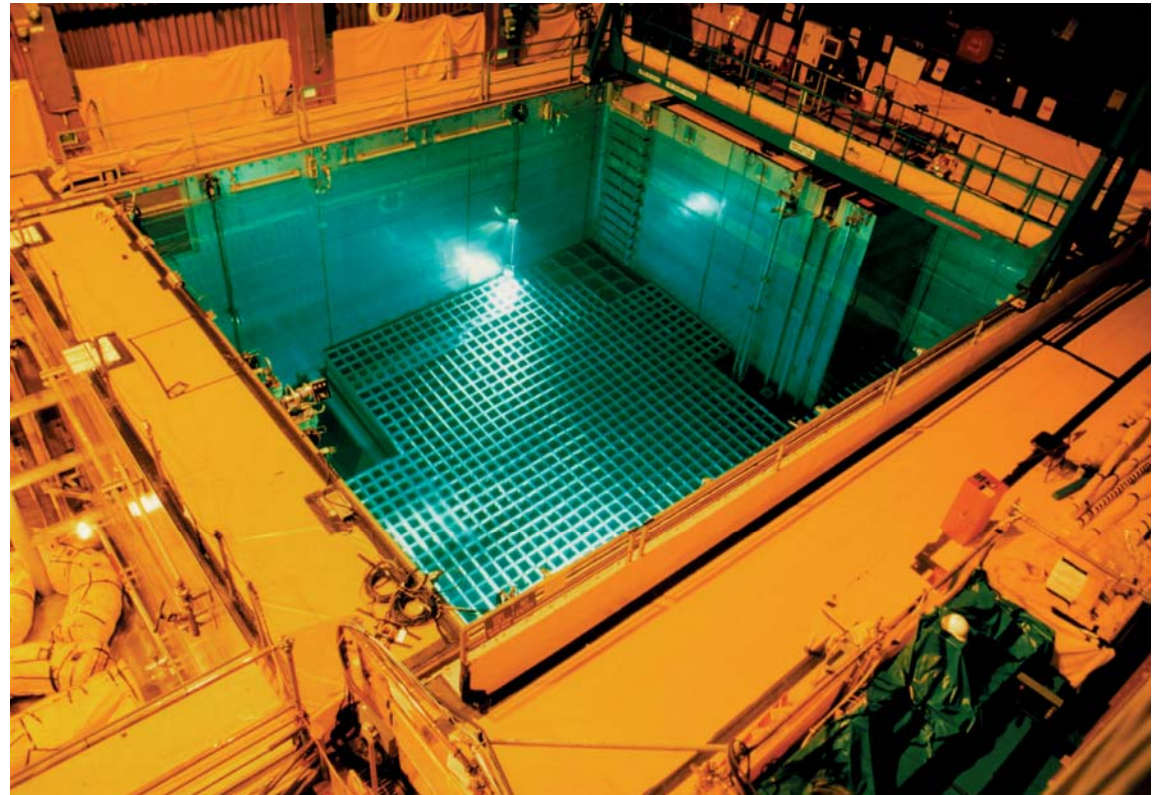


Spent Fuel Criticality: Neutron Absorbing Material Degradation Issues

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Nuclear Regulatory Commission
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Overview

- Regulatory perspective
- Material type
- Operating Experience
 - Historical Issues
 - Recent Events
- Path forward



Picture: Spent Fuel Pool

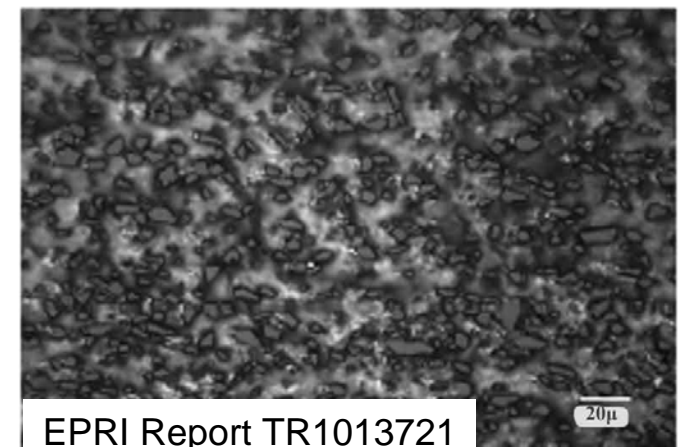
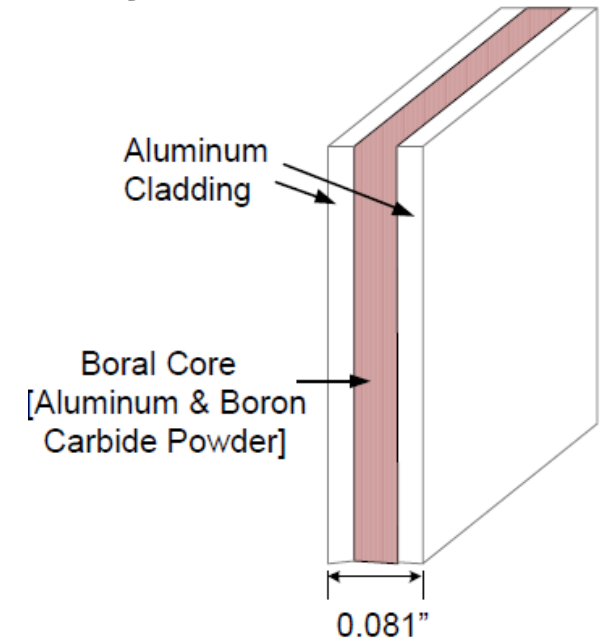


Regulatory Perspective

- Unidentified and unmitigated degradation poses a criticality and safety concern
- Challenges compliance with NRC subcriticality requirements: 10 CFR 50.68 and GDC 62
- GL-78-11 dated April 14, 1978
 - Suggested an inservice surveillance program
 - Verification of long-term stability by actual tests
- Monitoring program important to ensure subcriticality
 - In-situ testing (neutron attenuation)
 - Coupon surveillance (physical characteristics, visual, neutron attenuation)
 - Conservative prediction of future degradation

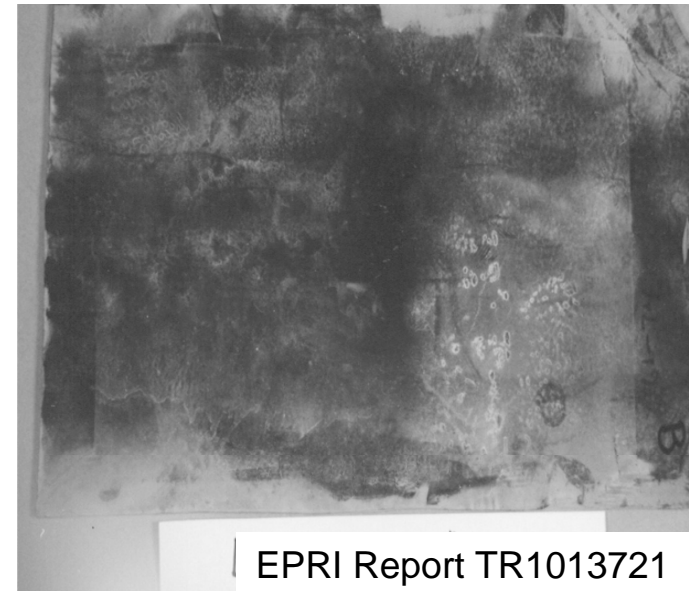
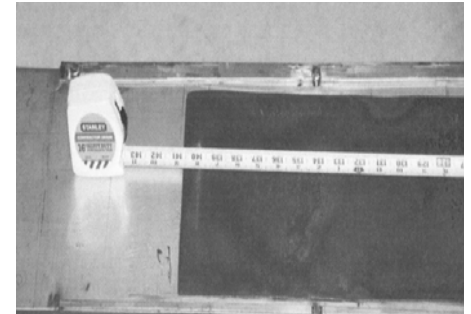
Material Type

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



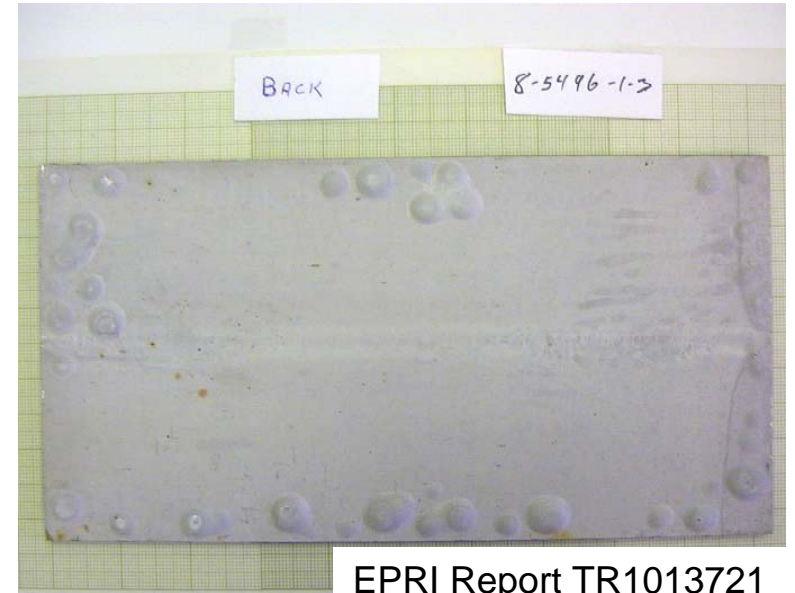
Historical Issues

- Boraflex (1970s-1980s)
 - Silica polymer matrix degradation
 - Cracking, shrinking, & gaps
 - INs: 87-43, 93-70, 95-38
 - GL 96-04: Maintain 5% margin
 - Surveillance program
 - BADGER testing
 - RACKLIFE predictive program
 - Corrective actions
 - Many plants stopped crediting Boraflex



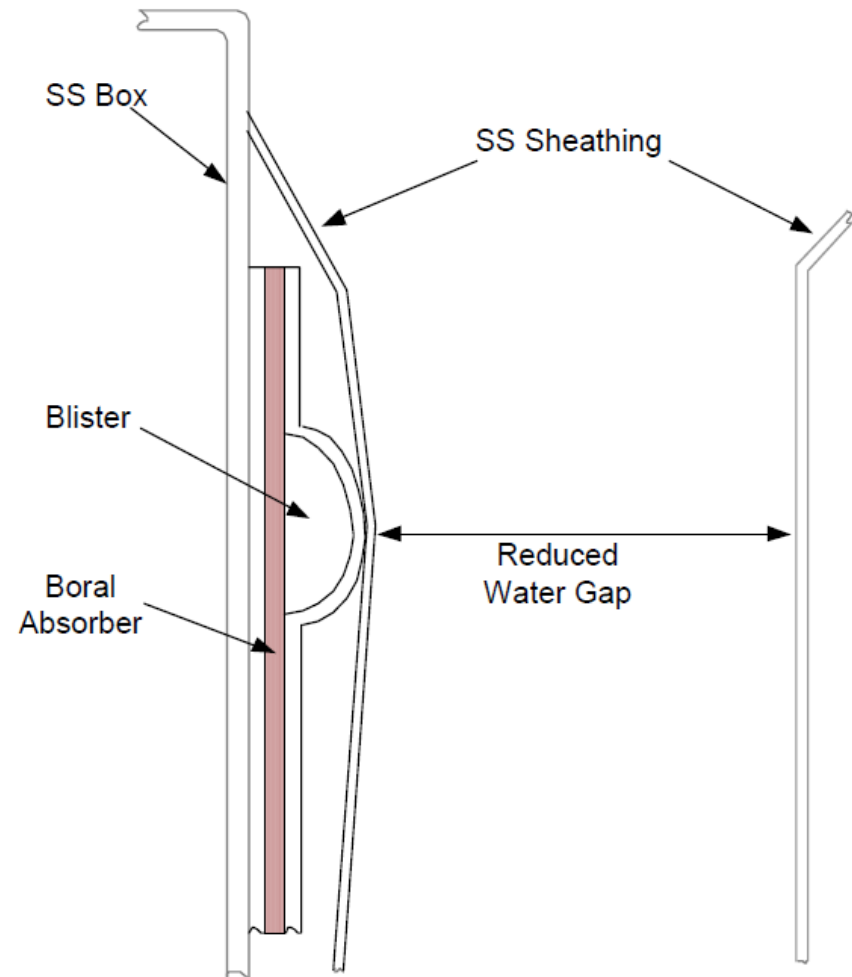
Historical Issues (con't)

- **BORAL®**
 - Pre-1980's BORAL®
 - IN 83-29
 - Blistering & bulging
 - Gas accumulation
 - Caused stuck fuel assemblies and unusable cells
 - Clad separates from the core and is plastically deformed outward away from the core.
 - Many plants with BORAL® drilled holes or clipped the corners in their fuel storage racks to allow gas to escape



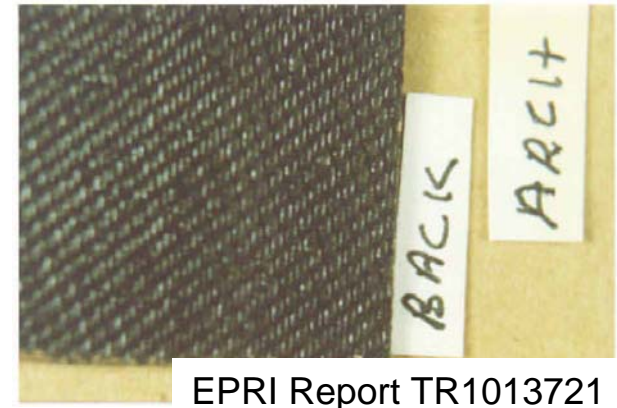
Recent Events

- **BORAL®**
 - Blistering
 - Seabrook 2003
 - Beaver Valley 2007
 - TMI 2008
 - Bulging
 - Susquehanna 2009



Recent Events (con't)

- Carborundum, Palisades 2008
 - Stuck fuel assemblies
 - BADGER testing found up to 70% degradation
 - Received a “White” finding in 2010
 - Lessons learned from recent events:
 - Surveillance program important to detect onset of degradation
 - Effective operating experience evaluation can lead to early identification
 - Unknown degradation mechanisms and rates could result in reduced subcriticality margins.





Path Forward

- Completed action
 - IN 2009-26 on recent material degradation events
- Current actions
 - Finalize LR-ISG 2009-01 on aging management of neutron absorbing materials in spent fuel pools
- Future actions
 - Dialogue with the industry on its next steps
 - Additional research to understand degradation mechanisms
 - Other generic communications, as necessary



Questions