U.S.NRC

UNITED STATES NUCLEAR REGULATORY COMMISSION

Protecting People and the Environment

Overview of Spent Fuel Pool Neutron Absorbing Material Degradation

Emma Wong

Nuclear Reactor Regulation/Division of Engineering

Steam Generator Tube Integrity and Chemical Engineering Branch

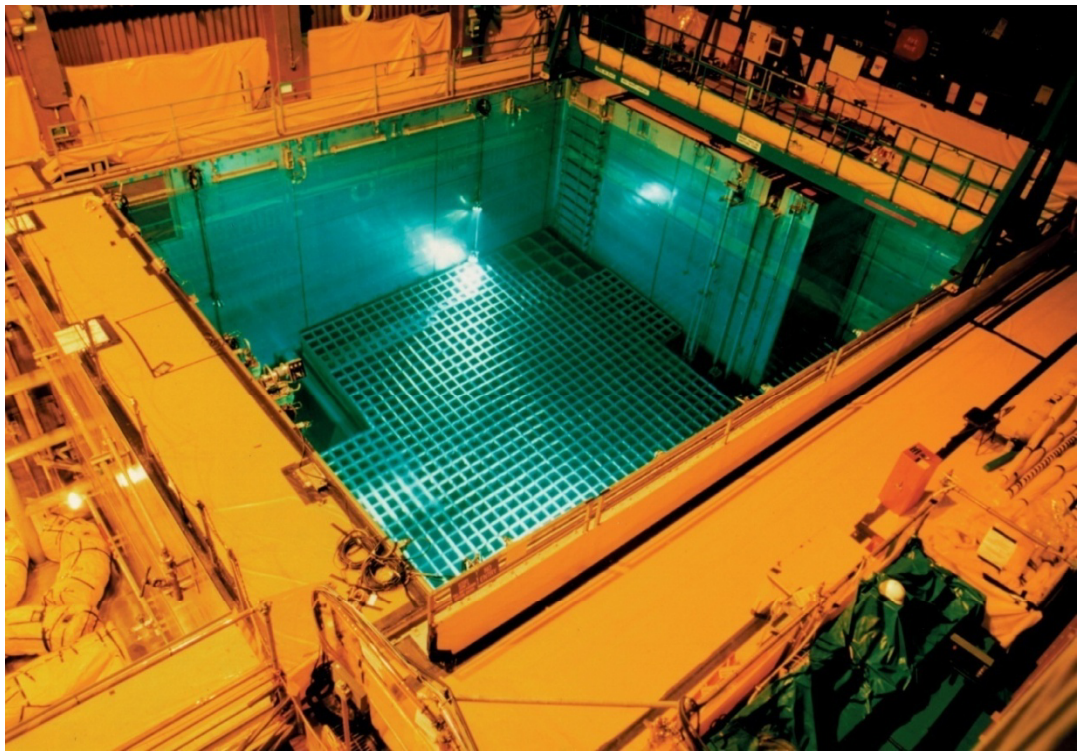
Public Meeting on Neutron Absorbing Material Degradation

October 4, 2012

U.S.NRC
UNITED STATES NUCLEAR REGULATORY COMMISSION
Protecting People and the Environment

Overview

- Safety Significance
- Material Types
- Historical Issues
- Recent Events
- Staff Observations
- NRC Questions
- NRC Actions
- Knowledge Base
- Surveillance Methodologies



Picture: Spent Fuel Pool

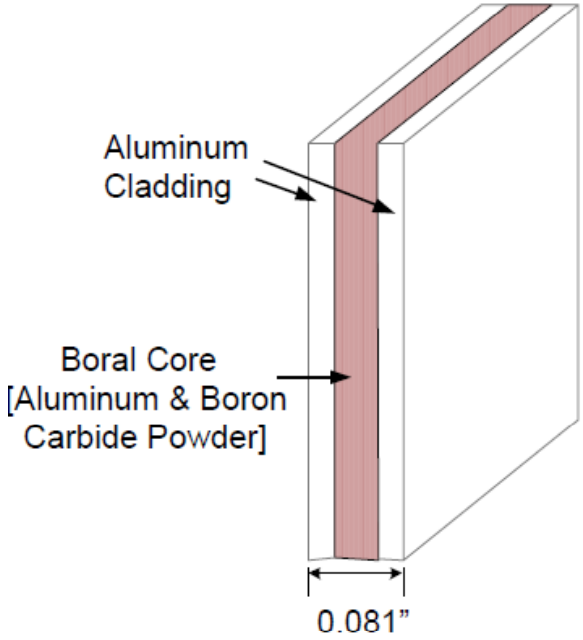
U.S.NRC
UNITED STATES NUCLEAR REGULATORY COMMISSION
Protecting People and the Environment

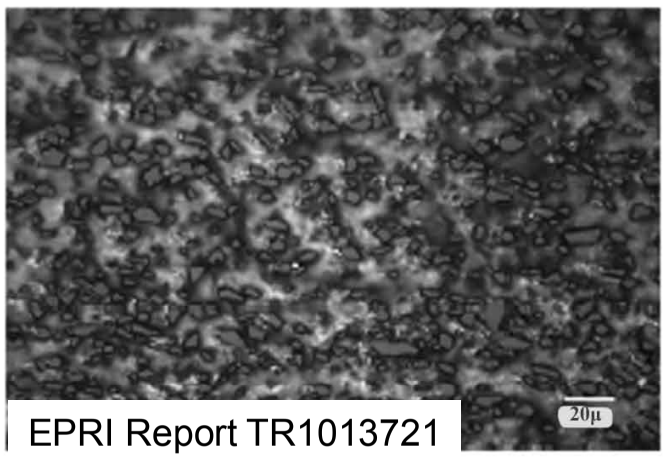
Safety Significance

- 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
  - Metal Matrix Composites
    - METAMIC®
- New Metal Matrix Composites
  - Bortec®
  - Alcan Composite



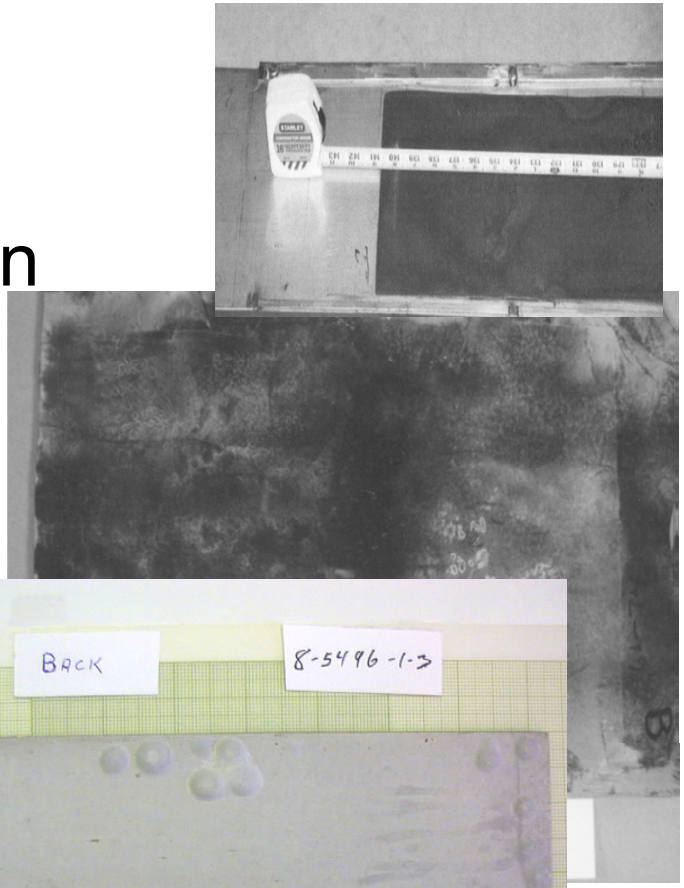


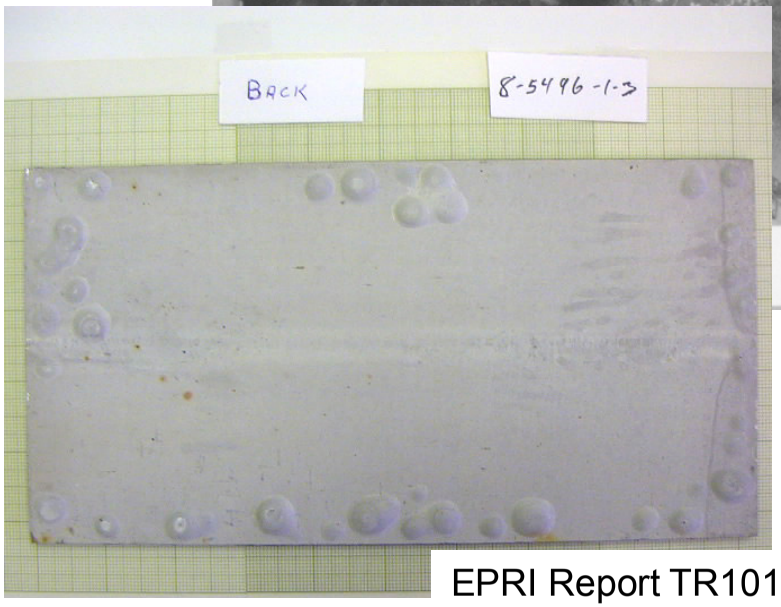
Pictures: BORAL® cross-section and Bortec® micrograph

Historical Issues

- Boraflex (1970s-1980s)
  - Silica polymer matrix degradation
  - INs: 87-43, 93-70, 95-38
  - GL 96-04: Maintain 5% margin

- BORAL® (1980's)
  - Blistering & bulging
  - IN 83-29





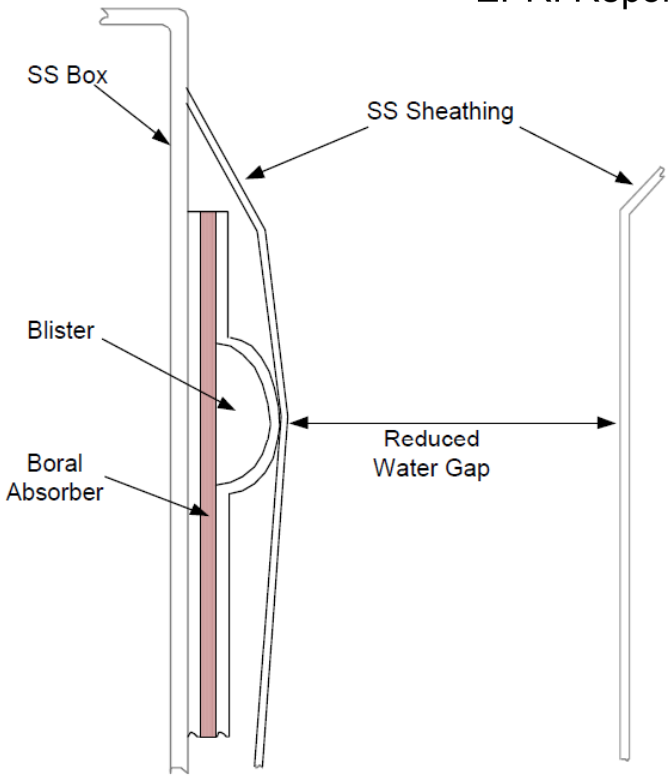
EPRI Report TR1013721

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

Recent Events

- Carborundum, Palisades 2008
  - Stuck fuel assemblies
  - BADGER testing found up to 70% degradation
- BORAL®
  - Blistering
    - Seabrook 2003
    - Beaver Valley 2007
    - TMI 2008
  - Bulging
    - Susquehanna 2009

EPRI Report TR1013721



Picture: Carborundum microphotograph and example of Boral blister and bulge

Recent Events (con't)

- Boraflex
  - Turkey Point Unit 3, 2010
    - Areal density was less than the licensing basis
    - Ineffective implementation of corrective actions
    - Ineffective in identifying and mitigating degradation
  - Peach Bottom Unit 2, 2010
    - Panels degraded below the TS requirements
    - Ineffective implementation of corrective actions
    - Monitoring and mitigating the degradation not adequate
  - IN 12-13

U.S.NRC
UNITED STATES NUCLEAR REGULATORY COMMISSION
Protecting People and the Environment

Staff 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.

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

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

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

Surveillance Methodologies

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