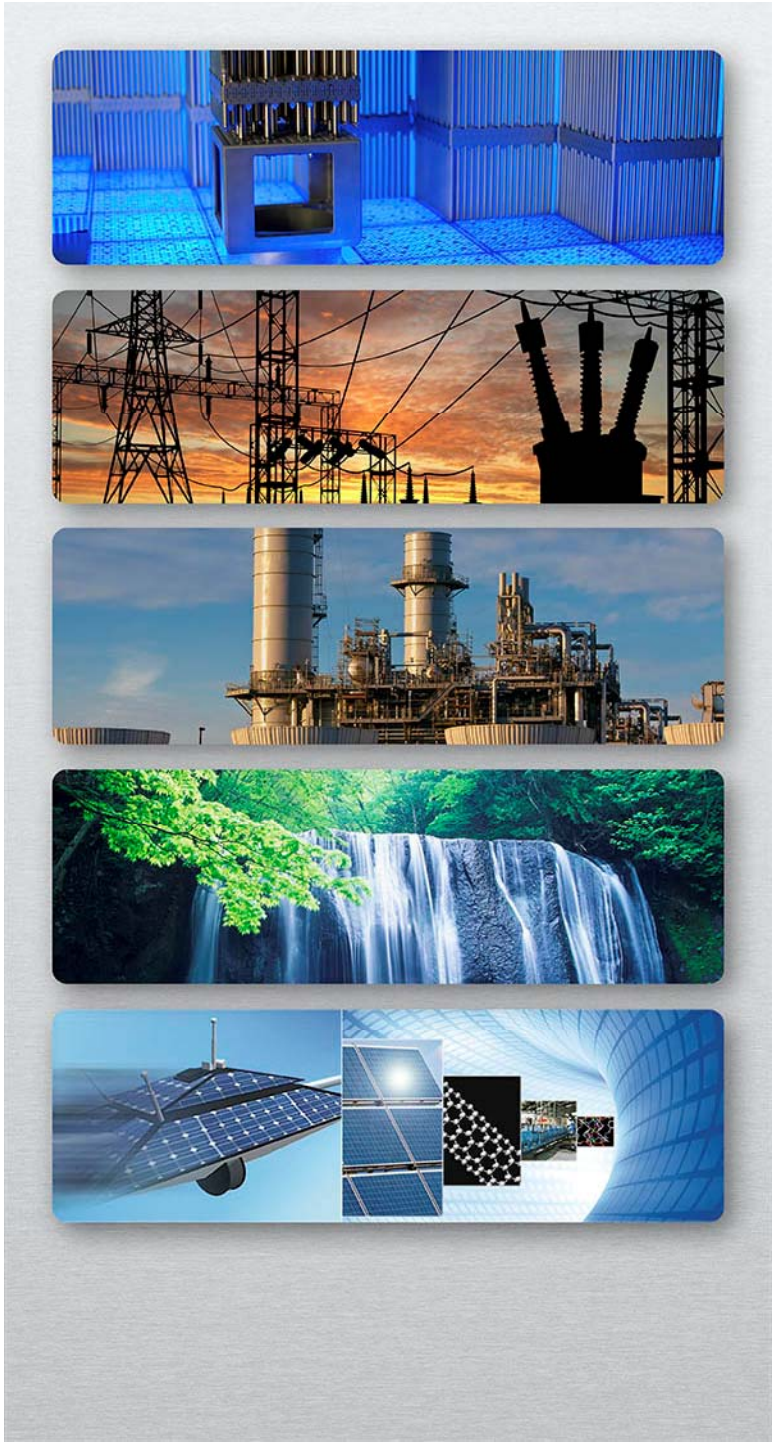


ELECTRIC POWER RESEARCH INSTITUTE

"Underappreciated Materials": Used Fuel Storage

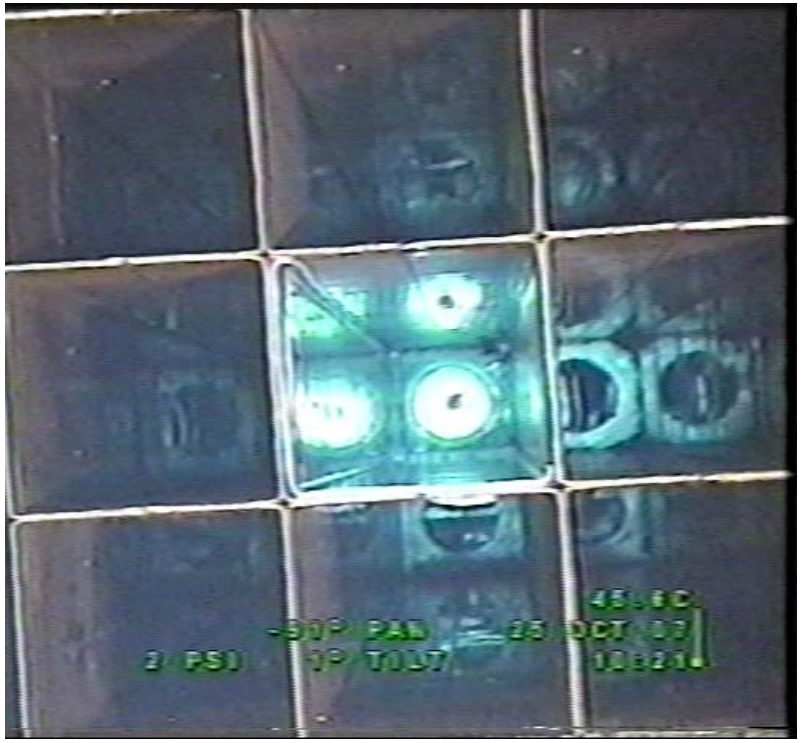
John Kessler
Manager, Used Fuel & HLW Management Program

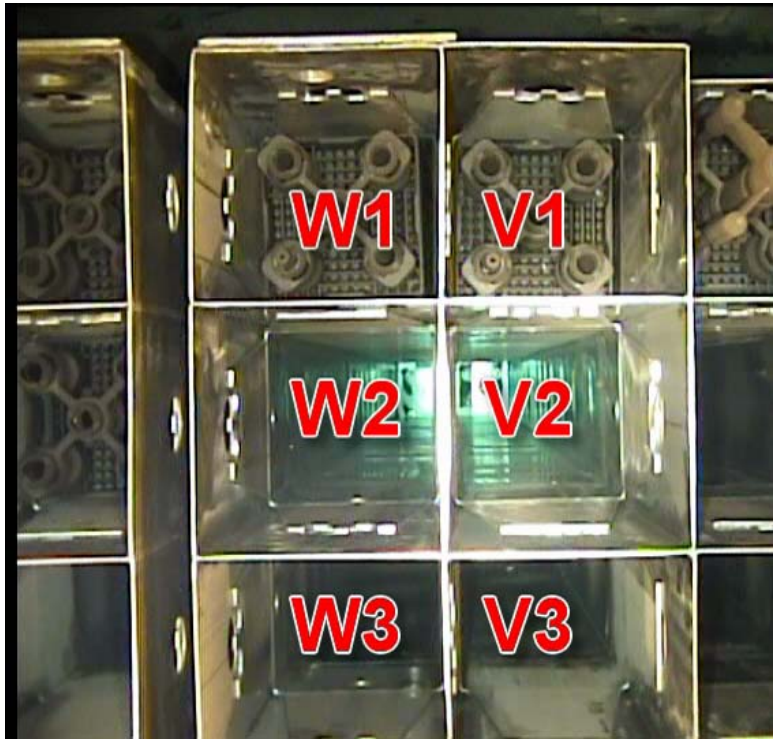
Life Beyond 60 Workshop
23 February 2011

Outline

- Spent fuel pool storage degradation issues
  - Neutron absorber materials degradation
  - Spent fuel pool liner leakage
- Dry storage and transportation system degradation for >60 years
  - Dry storage and transportation system description
  - Used fuel cladding
  - Storage/transportation canister
  - Storage concrete overpack

Spent Fuel Pool Absorbers Incorporated in Cell Walls



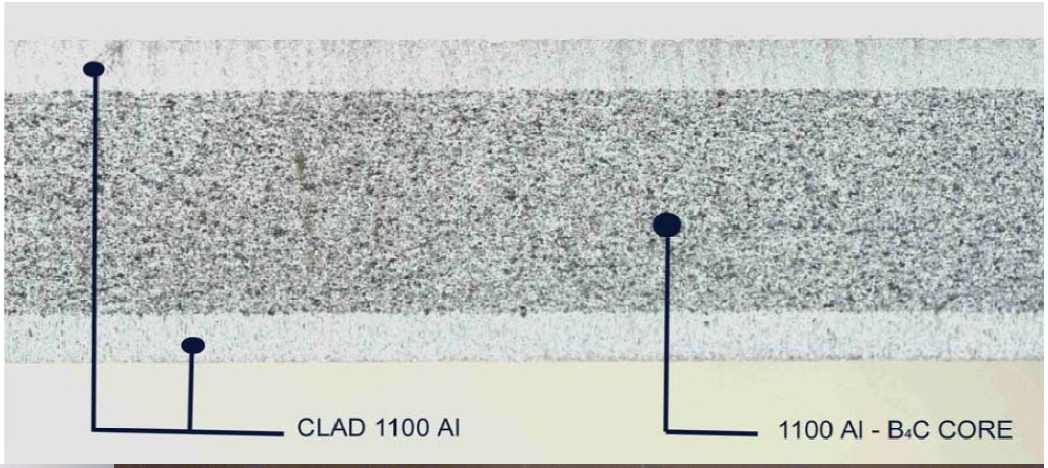


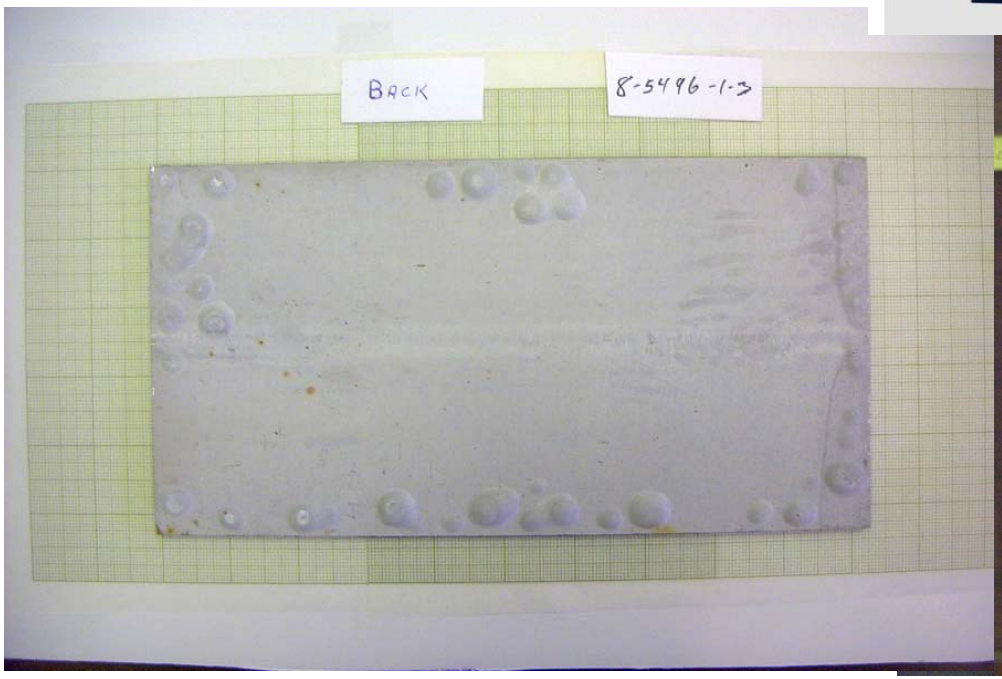
Spent Fuel Pool Storage Degradation Issues: Boraflex

- Silicon polymeric material impregnated with B_4C in widespread use in the 80's and 90's
- Cloudiness in pools noticed (high Si content)
- B_4C particles deposited throughout the pool
- Shrinkage and/or complete loss of B_4C. Major campaign to understand degradation.
- Today: utilities have either replaced or take little "credit" for the presence of Boraflex
- Similar degradation issues for Carborundum

Spent Fuel Pool Storage Degradation Issues: Neutron Absorbers (continued)

- Boral blistering
  - Expansion into storage cells
  - Hydrogen gas buildup





Dry Storage System Guiding Principles

- Disposal or reprocessing not likely for decades
- Current regulations: up to 120 years combined wet/dry
  - 60 years wet storage; 60 years dry storage
  - New NRC “waste confidence”: 60 years after end of reactor life
- Global interest: Not just a U.S. issue
- Storage systems will have to perform intended function beyond current licensing period

Technical bases for dry storage >60 years not yet demonstrated

Functions of Dry Cask Storage Systems (NUREG-1536)

- Thermal performance
- Radiological protection
- Confinement
- Sub-criticality
- Retrievability

Can existing and future dry casks maintain these functions for decades?

Temperature-related Dry Storage System Degradation Mechanisms

- Fuel cladding creep caused by increased cladding ductility and increased stress
  - Due to higher temperatures causing higher pressures inside the cladding
- Hydride reorientation in the spent fuel cladding
- Corrosion
- Degradation of neutron shielding
- Concrete dry-out and cracking

Changes as the System gets Cooler

- Mostly good things
  - Reduced metal creep rates
  - Reduced corrosion rates
  - Reduced gamma and neutron radiation
- Potential negatives (mostly related to cladding)
  - Additional hydride precipitation
  - Decreased ductility
    - *Potentially* more susceptible to breakage during storage and transportation

Aging Management R&D Needs

- Near-term: Maximize life of existing systems and ensure transportability
  - Additional data and analyses of long-term degradation mechanisms
  - Enhanced monitoring and inspection
- Intermediate-term: Evaluate mitigation/design options
  - E.g., anti-corrosion coatings, new cask designs
- "Eventually" (more costly, higher worker dose)
  - Canning
  - Repackaging
  - Over-packaging
  - Use risk-informed approach to decision making

When is "eventually"?

EPRI Initiated Extended Storage Collaboration Program (ESCP)

- Current participants:
  - US: EPRI (lead organization); NRC; DOE; utilities; vendors; NEI, NWTRB
  - Other countries involved: Brazil; France; Germany; Hungary; Italy; Japan; Netherlands; Spain; Taiwan; UK

- Workshops:
  - Initial workshop documented in EPRI Report 1020780 (March 2010)
  - May 2010: Baltimore
  - October 2010: London
  - December 2010: Charlotte

Purpose of the ESCP Program

- Evaluate what we already know
  - Existing analyses: how far out in time?
  - Existing data
  - Existing operational issues (e.g., loading, monitoring, testing)
- Identify the open items for even longer storage (gap analysis)
- Suggestions for what needs to be done (and how, if possible)
- Form a standing group to continue pursuing additional, appropriate R&D

ESCP Identified Three Major R&D Gaps (December 2010)

- Condition of used fuel at the time of transport
  - Main issues: hydride reorientation; creep
- Condition of the welded canisters
  - Main issues: canister general corrosion and stress corrosion cracking
- Structural and shielding properties of concrete
  - Main issues: behavior of concrete under elevated temperatures and radiation fields

Proposed EPRI Extended Storage Activities for 2011

- Manage ESCP Program
  - Support meetings/workshops (Baltimore; Berlin; TBD)
  - Coordinate R&D and regulatory issues within and outside the US
  - Identify and initiate areas of collaboration
    - Primary: full-scale, high burnup storage confirmatory program
- Primary EPRI R&D activity: in situ NDE of welded canisters
  - Identify available NDE approaches (visual, weld inspection)
  - Develop and demonstrate NDE techniques
    - Start with mock-up
    - Field demo(s) (“stretch goal”)

Proposed 2011 EPRI Extended Storage Activities (continued)

- Work with US vendors/utilities to obtain “marine environments” data
  - Looking for US volunteers
- Develop options for obtaining canister gas samples
- Document Peach Bottom experience
- Collect documentation of US and non-US experience with extended storage programs
- Coordinate with EPRI LTO and concrete degradation projects

Together…Shaping the Future of Electricity