Behavior of Spent Fuel In Dry Casks

Session 4, Chaired by
Ralph Meyer & Charles Interrante of NRC
[Tuesday, October 21, 2003, 11:00 am]

Today's Presentations

Argonne National Laboratories

- Cladding Behavior During Dry Cask Handling and Storage: H. Tsai, M. Billone
- Mechanical Properties of Irradiated Zr-4 for Dry Cask Storage Conditions and Accidents: R. Daum, S. Majumdar, M. Billone

Current Information Needs

Background, ongoing and planned work

- License Renewal Activities
  - Gave rise to “User Needs” related mainly to creep data
  - EPRI, DOE, NRC coordinated effort at INEEL, ANL
  - Surry’s Renewal Application is Already in Progress.
- Cask Behavior in Licensed Service
  - As Burnup levels increase, needs arise for improved modeling that requires better understanding of selected mechanical properties & fracture toughness data. Licensing activities require guidance for meeting the safety functions of the storage system: thermal, radiological, confinement, sub-criticality, retrievability.

License Renewal

Recent pertinent reports

- NUREG/CR-6831
  - "Examination of Spent PWR Fuel Rods after 15 Years in Dry Storage," [Einziger, et al., 2003]
    - Residual Creep Capacity of Surry Fuel taken from INEEL's Castor V/21 is shown to be adequate for the storage, transport and disposal parts of the fuel cycle.
- ASTM Standard Guide "C 1562 - 03"
  - "Evaluation of Materials Used in Extended Service of Interim SNF Dry Storage Systems"
    - [ASTM TG under C26.13 on Spent Fuel and High Level Waste]
    - This guide followed an NRC sponsored study by SAIC on "Technical Basis for License Renewals for ISFSI."

Cask Behavior in Licensed Service

- Mechanical Properties & Fracture Toughness of a Fuel Assembly
  - Model the behavior over pertinent temperatures for fuel assemblies using estimates of condition and properties along the lengths of the each rod and within each assembly.
- Cladding Behavior Models for SNF Assembly for abusive and accident service conditions
  - Fracture Modeling
    - Fuel cladding condition (oxides & hydrides along the length of the rods)
    - Fracture by brittle or ductile mode: fracture toughness, impact strength, and stress / strain to fracture are needed.
  - Dispersion Modeling of Fuel
    - Pellet fracture properties as function of service conditions: e.g. higher burnup levels lead to fine-grained structure in the rim of the pellet

Cask Behavior in Licensed Service

Continued

- Hydrides in Zirconium based Clad Materials
  - Circumferential hydrides form in reactor service and their volume fraction increase with H content.
  - Radial hydrides seem to form from supersaturated solution at stress levels above ~90 MPa.
  - Thermal cycling at high tensile stress promotes radial hydride precipitation.
  - Embrittlement increases potential for longitudinal fracture of rods.