Dry Cask Storage of Nuclear Spent Fuel

Division of Spent Fuel Storage and Transportation
U.S. Nuclear Regulatory Commission
Overview of Dry Cask Storage
Used Nuclear Fuel in Storage
(Metric Tons, End of 2009)
Historical and Projected SNF Discharges

SOURCE:
Impacts Associated with Transfer of Spent Nuclear Fuel from Spent Fuel Storage Pools to Dry Storage After Five Years of Cooling, EPRI 11/10
Dry Cask Storage

- 63 licensed ISFSIs (8 more than 2010)
- Expect 10 sites pursuing General License
- Over 1400 loaded storage casks
At-Reactor SNF Dry Storage Facilities

SOURCE:
Impacts Associated with Transfer of Spent Nuclear Fuel from Spent Fuel Storage Pools to Dry Storage After Five Years of Cooling, EPRI 11/10
Examples of Dry Cask Storage
Oconee ISFSI

• Site-Specific License issued to Duke Power January 31, 1990
  – 20 year license
  – Oconee switched to General License NUHOMS in 1998
  – 84 NUHOMS-24P systems loaded under site-specific license
  – 44 NUHOMS-24P systems loaded under general license

• Issued Oconee renewal on May 29, 2009 for 40 years
McGuire ISFSI

- Initial loading in 2001
- 10 TN-32 casks loaded under site-specific license
- 26 NAC-UMS casks loaded under general license
- In 2010 began using NAC International’s MAGNASTOR system under general license
Fort St. Vrain ISFSI
Private Fuel Storage

- Application submitted June 1997
- License issued February 2006
- Toole County, Utah
Private Fuel Storage

• HOLTEC Hi-Storm 100 Cask System
• 200 Canisters per Year Average Intake
• 40,000 MTU (4,000 Canisters)
Status of Private Fuel Storage

- PFS has an NRC approved license.
- BIA denied approval of PFS lease and BLM denied approval of right-of-way for rail line.
- Skull Valley Band of Goshute Indians, and PFS sue Department of Interior for review of BLM and BIA decisions.
- U.S. District Court for Utah remands BLM and BIA decisions to DOI for reconsideration (July 2010).
Current NRC Regulatory Framework for Storage Certificates

Renewable Term Licenses

Aging Management Plan
  Time-limited aging analyses
  Design for prevention
  Monitoring – how, how often, in-situ
  Maintenance – what type
  Corrective Actions – when
Technical Review Guidelines

• Standard Review Plan for Dry Cask Storage Systems (NUREG-1536)

• Standard Review Plan for Spent Fuel Dry Storage Facilities (NUREG-1567)

• Standard Review Plan for Renewal of Spent Fuel Dry Cask Storage System Licenses and Certificates of Compliance (NUREG-1927)

• Interim Staff Guidance Documents
The overall risk of dry cask storage was found to be extremely low.

The estimated aggregate risk is an individual probability of a latent cancer fatality of $1.8 \times 10^{-12}$ during the first year of service, and $3.2 \times 10^{-14}$ per year during subsequent years of storage.
Examination of Spent PWR Fuel Rods after 15 Years in Dry Storage
-NUREG/CR-6831

• Based on the Surry fuel rod data, no deleterious effects of 15-years of dry cask storage were observed.

• Creep testing indicated that the cladding retains significant creep ductility after dry-cask storage.

• Creep would not increase appreciably during additional storage because of the low temperature after 15 years.

• Hydrides appear to have retained a circumferential orientation
Typical Dry Storage Cask Operations
Spent Fuel Storage Casks

Dual Purpose Storage Cask*

- Cask Lid
- Steel Cannister 0.5 in.
- Bundles of used fuel assemblies
- Concrete Wall 26.75 in.

(Holtec International HI-STORM 100)

Overall Length: 197 to 225 in.
Loaded Weight: 360,000 lbs.
Typical Payload: 24 PWR Bundles

* Storage and Transportation

Dual Purpose Cask*

- Cover
- Cask Lid
- Steel Wall 7.5 in.
- Neutron Shield 6 in.
- Bundles of used Fuel Assemblies
- 132 in. dia.

(Transnuclear TN-68)

Overall Length: 178 in.
Loaded Weight: 240,000 lbs.
Typical Payload: 68 BWR Bundles
Preparation of Empty Canister
Fuel Loading in Transfer Cask
Welding of Canister Lid
Transfer of Canister into Overpack
Transfer of Overpack to ISFSI Pad
Storage Cask Array on ISFSI Pad
Transfer of Canister into Module
How do we get spent fuel out of pools?
PWR Assembly Decay Heat Curve

Figure 2-2
EPRI Estimates of Dry Cask Loadings needed to move Spent Fuel into Dry Storage after 5 years

Figure 4.1
Comparison of Dry Storage Systems Loaded Annually Under the Industry Base Case and the Industry 5-Year Cooled SNF Case

600 - 800 casks loadings per year. Four times normal rate.
EPRI Estimates of Total Dry Cask Loadings resulting from moving Spent Fuel into Dry Storage after 5 years

Figure 4-2
Cumulative Dry Storage Systems Loaded Under the Industry Base Case and the Industry 5-Year Cooled SNF Case
How did we get where we are now?
Existing Storage and Transportation Regulations

• Current storage and transportation regulations are flexible enough to:
  – accommodate a wide range of operational and design conditions
  – support future changes in technology/policy (because they are based on performance requirements rather than specific technologies).

• Current storage and transportation regulations permit operational and design conditions:
  – that do not have same end and beginning points
  – that are based on costs or policy optimizations of a single fuel cycle phase
  – may result in extra operations or inconsistencies
Integration of Storage and Transportation

Storage and Transportation can be integrated by requiring licensees to lay out a proposed transportation strategy before they are granted approval to store. The strategy would replace 72.108. It may look like:

- **Storage Only**
  - Must maintain wet or dry unloading/loading capability

- **Dual Purpose Cask**
  - Must have design approved under Parts 71 and 72 and have hardware aging plan for life of storage

- **Canister Based System**
  - Must have an approved canister design under Part 72 that can be shown to be transportable in a Part 71 approved overpack at the proposed time of shipment

Integrating Storage and Transportation will not directly address disposal.
Integration of Storage/Transportation and Disposal

Need to know repository design parameters such as canister size and heat loads, and role of fuel cladding to integrate regulation of repository operations
Developing a Regulatory Framework for Extended Storage and Transportation
Regulatory Needs

Confidence Decision
  Updated in 2010 for licensed life plus 60 years
  Commission directed staff to prepare separate long-term update for beyond life plus 60 years

Extended Storage and Transportation (EST)
  Potential changes to regulations and guidance
  Opportunity to improve integration of storage and transportation regulations and guidance
  Technical needs
  Risk informing
Technical Basis for EST

Technical Gap Assessment
  Component performance
  System performance
Implications for Aging Management
Implications for Transportation and Disposal (or Reprocessing) after Extended Storage
Coordination with Analysis of Environmental Impacts for Long-term Update of Waste Confidence Decision
Example: Cladding Integrity

Safety Functions
- Primary fission product barrier
- Geometry control
- Defense in Depth

Technical Challenges
- Higher burnup levels
- Temperature effects
- New cladding types
- In-situ monitoring in sealed canisters
Example: Canister Integrity

Safety Functions
Confinement
Inert environment
Criticality control

Technical Challenges
Long-term corrosion
Basket properties
Absorber efficiency
Monitoring sealed internals
Example: Overpack Performance

Safety Functions
  Shielding
  Heat transfer
  Robustness against severe events

Technical Challenges
  Long-term degradation
  Response to external natural events and external...
Path Forward: Phase 1

Synthesis of Technical Gap Assessments
  Draft synthesis report for comment, Fall 2011
  Final synthesis report, Spring 2012

Regulatory Plan
  Integration of EST regulatory needs and
  Waste Confidence long-term update
  Research plan to address technical gaps

Cooperative Research (e.g., ESCP)

Stakeholder Involvement